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To aid in uniformity of presentation, it is requested that: —

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All lettering on prints and all drawings and charts be made in black India ink.

Legends be furnished in separate lists numbered to correspond with the illustrations.

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Jones, J. A.: Treatment of Club-Foot. Surg. Gynec. Obstet., LXXIII, 56, 1926.

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Jones, J. A.: Textbook of Orthopaedic Surgery. Ed. 3. Philadelphia, Brown and Graham Co., 1927.

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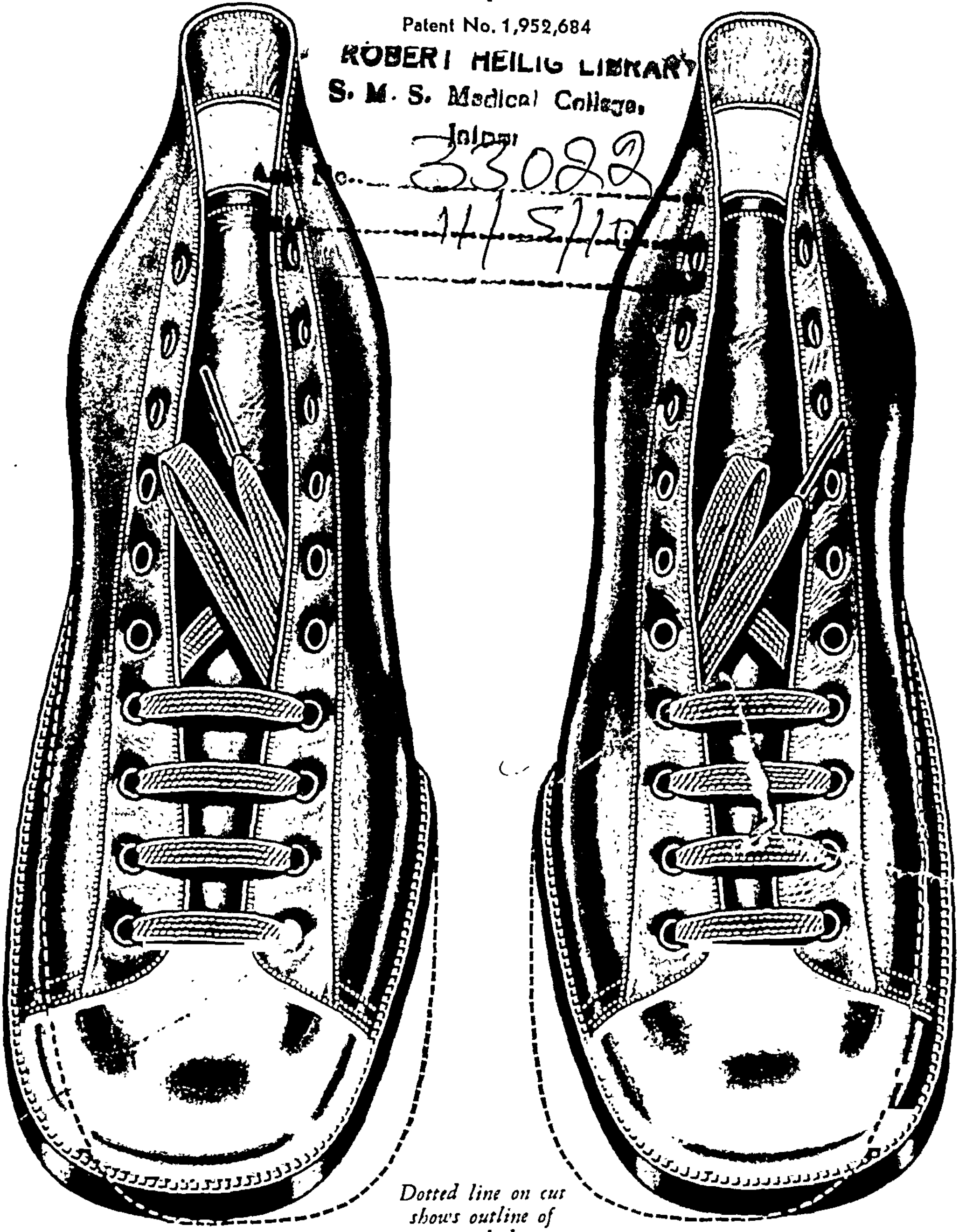

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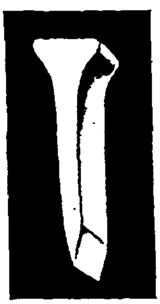

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TABLE OF CONTENTS

(Continued on page 13 following Current Literature)

VOL. XVII, NO. 3 JULY, 1935 Old Series Vol. XXXIII, No. 3

The Journal of Bone and Joint Surgery

THE PRESIDENT'S ADDRESS *

BY DE FOREST P. WILLARD, M.D., PHILADELPHIA, PENNSYLVANIA

The first and most pleasant duty that faces your President is the privilege of greeting the members of the American Orthopaedic Association and their guests. I can speak both for myself and for the other members of the Philadelphia group, that it is with the greatest delight that we welcome you to this, the fourth meeting of the Association in this city. Forty-five years ago, in 1890, my father first had this pleasant duty; and since then Dr. Augustus H. Wilson, in 1902, and Dr. Gwilym G. Davis, in 1914, have also been privileged to extend to you a heartfelt welcome. It is with a feeling of deepest gratitude that I express my thanks to the Association both for allowing me to be the spokesman for Philadelphia at this time and for doing us the honor of meeting here.

The President's second duty, unpleasant as it may be from the standpoint of his audience, is to deliver an address. It seems to me that I can best undertake this duty by falling back on the precedent set by many of our former presidents, and giving what might be called a short editorial on the activities of our Association during the forty-eight years of its existence and on the responsibilities that, to my mind, face it in the near future.

Conditions have changed greatly since the Association first met in Philadelphia forty-six years ago. Only three years previously it had been created by a small group of men, meeting on January 29, 1887, in Dr. Newton Shaffer's office in New York. Six months later, under the leadership of Dr. Virgil Gibney, it held its first official meeting.

These early years were years of struggle for recognition of our specialty. In reading between the lines of the earlier presidential addresses, it is easy to see that both the medical profession and the public were loath to recognize orthopaedics as a surgical entity. In those days, the orthopaedist was considered to be only a fitter of apparatus. His contemporaries called him a "buckle-and-strap man". Indeed, the papers

* Read at the Annual Meeting of the American Orthopaedic Association, Philadelphia, Pennsylvania, June 5, 1935.

read during the first fifteen years of our existence give credence to this idea, since they were devoted almost entirely to treatment by mechanical appliances. For example, at the Annual Meeting in 1893, only one paper out of thirty-one dealt with surgical procedures, and even such subjects as "A New Method of Curing Soft Corns" and "The Mechanical Treatment of Ingrown Toe Nails" were discussed by eminent authors. A few years later, Dr. Steele of St. Louis made mention in his Presidential Address of the fact that he had been invited to give a course of lectures in a St. Louis medical school, and that the subject chosen for him was "Orthopaedics and Joint Diseases".

Dr. Samuel Ketch in his address in 1897, ten years after the founding of the Association, reviewed the papers read during that period and his summary showed that 113 of the papers were on various questions relating to surgical tuberculosis, forty-three were on club-foot, fourteen on congenital dislocation of the hip, twenty on lateral curvature, nine on rickets, and only six were on the deformities of infantile paralysis, with seventy papers unclassified. Only 8 per cent. of these papers discussed operative procedures for these conditions, and most of these measures were simple tenotomies or aspirations.

In 1896, Dr. Royal Whitman said before the Association that "The application of a brace rather than the treatment of disease and deformity is still, in the minds of many, the distinctive and essential feature of the specialty"; and, in 1897, Dr. Virgil Gibney urged in his paper that "the orthopaedic surgeon should be prepared to conduct a case from incipiency to close and that if apparatus fails to meet the indications, he should be able to conduct an operation, which operation ought to be as well done as any general surgeon can do it, and which operation he can supplement by the judicious use of mechanical appliances".

However, orthopaedics was attracting many men who were skilled in the operative procedures, and these men gradually taught both our own members and the world at large that the orthopaedic surgeon was able to handle his cases "from incipiency to close" and could conduct an operation with all the skill of the general surgeon.

In the early years of this century, the teaching of these men began to bear fruit. The papers read in this period, while often still dealing with the all-important subjects of tuberculosis and congenital and postural defects, began to touch more and more on the operative problems. Before 1900 the only major surgery that was advocated was destructive in character,—excision of the hip for tuberculosis being the most commonly mentioned. But with the turn of the century our members began to develop the more constructive types of operations. Infantile paralysis and the operative reconstruction of its deformities became more and more important. Bone grafting made its debut in orthopaedic circles, restoration of joint function after disease became a fact instead of a hope, and prevention rather than correction of deformity was strongly stressed.

By the time that this Association celebrated its twenty-fifth birthday

in 1912, our specialty was evidently firmly established. Dr. Gibney, in his presidential address in that year, implied clearly that the fight for recognition had been won, and that from then onward our specialty could be considered as having reached young manhood and being in a position to develop to the full capacity of its members.

The World War, perhaps, brought a greater advance in orthopaedics than in any other specialty. I firmly believe that this advance was in a large part due to the breadth of vision and wise leadership of the men who were chosen to take charge of the military orthopaedic work both at home and overseas. I am sure that all of us who had the privilege of serving under Colonel Goldthwait and his assistants were convinced that the orthopaedic problems of the American Expeditionary Forces were visualized more promptly and more broadly and prepared for more efficiently than were those of any other specialty. From a group that concerned itself mainly with the correction of the deformities of handicapped children, we suddenly expanded to one that dealt with all the lesions of the locomotor system. It was but natural, therefore, that a very large number of keen younger men were attracted to orthopaedic surgery, and in the post-war years their influence has had a marked effect in the development of the specialty.

In the fifteen-year period following the War, the surgical side of orthopaedics has been especially stressed, the technique of earlier surgical procedures has been perfected, and the widening of the field of correction by operation has advanced rapidly. The surgical treatment of tuberculosis, infantile paralysis, and many of the postural defects has become much more efficient. It is possible that, in our enthusiasm for rapid surgical reconstruction, we have failed to utilize in full the basic mechanical principles that our elders found so useful. Certainly, these principles should not be forgotten, but should remain as part of the equipment of every orthopaedist and should be blended with our new-found surgical skill.

In the past, it seems to me, our specialty in America has gone through three distinct periods of growth: first, that of mechanical treatment of deformity; second, that of surgical development; and third, that of advancement of surgical technique.

Now it seems that we are entering another period. The old problems still exist. We have not yet conquered many of our pathological enemies. Surgical technique is still being perfected. Prevention of deformity and the knowledge of the relationship of biochemistry to body growth and mechanics are still in their infancy. In addition, however, we are now being confronted with different types of problems of a social and educational nature which are as vital for us to recognize and solve.

Since the War, the expansion of all specialism has been very rapid. The number of men who now practise our own speciality has grown from a few score to many hundreds. These men have needed an outlet for their clinical and scientific experience. Our Association could not fulfill this

need, but the new American Academy of Orthopaedic Surgeons has supplied this outlet and, with the close affiliation of this Academy with our own Association, we have a combination that should have great influence in the growth of orthopaedic surgery.

In the early days, any attempt to standardize the requirements for the practice of orthopaedics was unnecessary, but, with the larger number of men now interested, it has become of vital importance not only to us, but more especially to the public which we must serve, that such men have the stamp of approval of some well recognized medical body. Of the twelve specialities now recognized by the American Medical Association all but two have felt the need for this certification of specialists. As in the other specialities, we have answered this problem by the formation of the American Board of Orthopaedic Surgery, which has among its members representatives of this Association, of the American Academy of Orthopaedic Surgeons, and of the Section on Orthopaedic Surgery of the American Medical Association. This Board has already formulated its rules and begun its work. It holds its first formal examination during the coming week. It deserves, and should have, the wholehearted backing of our Association and of us as individuals. Only with this cooperation can its work be carried out with the same thoroughness with which it has begun, and its certificate have the distinct value both to the members of our profession and to the public that it deserves.

Closely allied to this question of certification is the problem of teaching both in the undergraduate and graduate schools. It seems to me that, at the present time, the undergraduate teaching in practically all the specialities is giving too much time to operative technique and too little to the fundamentals of diagnosis. In our own specialty, for example, undergraduates should be trained to recognize the diseases and deformities of the locomotor system and to give what may be called orthopaedic first-aid to such cases; but to me it seems that the hours which the students spend in operating amphitheatres, seeing only the posterior elevations of a group of surgeons clustered around an operating table, are in very large part wasted. It also seems to me that another basic theorem of teaching should be that a medical graduate should not decide to specialize until he has spent several years in general medical or surgical practice. Then, and then only, should he be admitted to a postgraduate course in his chosen specialty for training in the complicated details of diagnosis and surgical procedures. Here at the University, we have formulated a plan of postgraduate teaching which we believe covers the essential needs. In orthopaedics, as an example, we have tried to pick men with proper background of general medical and surgical knowledge. We have tried, during the first year of their postgraduate training, to review the essentials of anatomy, chemistry, and pathology; and to give our students as diversified a training as possible in the clinical branches, in the out-patient departments, the wards, the operating room, and in the allied specialities.

In the second year, we have placed our students under the preceptorship of capable orthopaedic men outside of the University group, so that the students may get as broad and varied a viewpoint as possible; and, lastly, we endeavor to add a third year of practice and research under capable supervision. This combination is, we believe, the most efficient basis for further orthopaedic advancement that we can devise.

There is one further problem that is at present facing all medical men and that warrants our most careful consideration. In these years of depression, when all the world is looking for relief from the social, financial, and physical ailments that beset it, there has grown up a belief that any change must necessarily be a change for the better and, possibly based on this theory, there has spread among the public the belief that a change in the present relationship between the medical profession and its patients must be made. It is not in the province of this address to discuss the rights and wrongs of this theory, but it is within its province to state most earnestly that such a change is today a very live subject, and that, for the sake of ourselves and our patients, we must realize that as individuals and as an organization we must do our part in shaping these new theories along lines that will work out for the good of all concerned. If we wish to see the problems of medical insurance and of socialized medicine worked out for the best advantage of both patient and physician, we must both think and act on them. If the profession does not take the lead in these matters, the laity will; and unfortunately the politician and the demagogue are only too likely to be the ones to shape public opinion and to write the laws.

I realize that in a paper such as this any picture of the growth of American Orthopaedic Surgery, in which this Association has played such a vital rôle, must be very inadequate. But, because of my intense interest in this Association, which started in my early childhood when I had the privilege of hearing and seeing the great leaders of our specialty in my father's home, and which has increased steadily during my own membership in the Association, I have tried to point out to you the very meager beginnings of our "buckle-and-strap" men, and the extraordinary expansion in the technique of both diagnosis and treatment that has taken place since these men first organized the American Orthopaedic Association. It seems hard to believe that our fiftieth birthday is still two years away, and that these changes have occurred in so short a period. While we orthopaedic surgeons of today may feel that our organization has been responsible for much of this expansion, we must realize what a great debt we owe to our elders who prepared the field and who planted the seed. We are the care-takers of a great heritage which these men have left to us, and our greatest responsibility is that we shall struggle to solve the pressing problems of today in such a way that we may pass on to our successors a still more perfect inheritance of which both we and they may be very proud.

THE RADICAL OPERATIVE TREATMENT OF BONE AND JOINT TUBERCULOSIS *

BY PROF. DR. PHILIPP J. ERLACHER, GRAZ, AUSTRIA

TRANSLATED FROM THE GERMAN BY W. P. BLOUNT, M.D.,
MILWAUKEE, WISCONSIN

Every discussion of the treatment of bone and joint tuberculosis must begin with the admission of two facts: (1) We are dealing with metastases from an old and persistent focus, and not primary disease of the bones or joints; (2) The course of the disease is extremely chronic so that months and years may elapse between the secondary implantation and the appearance of symptoms from the metastases. The first fact emphasizes the folly of contenting oneself with treatment of the local process instead of giving careful attention to the source of the infection and the general condition. The second points out that the anatomical changes appear long before the clinical evidence of disease, so that actually we cannot speak of "early" diagnosis or "early" treatment in surgical tuberculosis.

TABLE I

JOINT TUBERCULOSIS

Indicatio Oeconomica

Duration?? Expenses??

Indicatio Morbi
Treatment of Tuberculosis

Indicatio Orthopaedica
Treatment of the Joint Disease

Tuberculous Infection → Initial Lesion → Secondary Metastases → in { Glands, Lungs, Skin, Soft parts } Bones, Joints { Healing with normal function; Good result with disturbed function; Bad result with disturbed function }

Miliary Extension Exitus

Every tuberculous metastasis to bone begins anatomically as a small circumscribed focus starting from embolic tuberculous material. For weeks, months, or even years, the focus develops unnoticed until finally clinical manifestations are evident. Only after the process is extensive enough to protrude on the surface or lessen the supportive strength of the

* Presented at the Ninth Congress of the International Anti-Tuberculosis Association, Warsaw, 1934.

bone is it evident clinically. But even then it develops slowly, so that there is plenty of time for an early clinical diagnosis.

TABLE II

JOINT TUBERCULOSIS

	Clinical Early Stage Onset	Clinical Late Stage Disease	Result
Duration:	Months—years	2–4–6 years or more	? Recurrence
Focus:	Isolated	Diffuse extension	Healed
Joint:	Normal	Destroyed	Ankylosis; bad position
Function:	Free — Limited	Eliminated	Useful
Treatment:	?	Conservative	———
Operation:	Extirpation to combat infection	Resection	Arthrodesis } for function Osteotomy } for function

The preparation for every form of treatment implies the making of a diagnosis and the exact determination of the location and extent of the tuberculous involvement. Here we are greatly aided by improved modern x-ray technique. Only with its help can we correctly judge as to the possibility of radical treatment and the favorable time for it. One must not try to save plates. Exposures must be made in several positions to visualize the location and extent of the individual focus (Figs. 1-A to 1-D).

This paper will be limited to tuberculosis of the bones and joints. To better summarize the subject it may be outlined as follows:

I. *Involvement of the Whole Bone with Secondary Invasion of the Joint:* If the process attacks only a small bone of the hand or foot, we find most of the bone diseased by the time there are evident clinical manifestations. Soon the adjacent joint surfaces are also involved. The same is true also for disease of the vertebral bodies which are so deep that an early diagnosis is difficult.

II. *Partial Involvement:*

A. *Involvement of the diaphysis without joint invasion.* The type occurs in the phalanges, metacarpals, metatarsals, and also in the ribs and flat bones of the skull and scapula. In all of these, joint involvement is not likely, and is rarely present in the clinical early stage.

B. *Involvement of the bone ends; epiphyseal lesion with and without joint invasion.* In the case of one of the long bones tuberculosis occurs in the metaphysis, rarely in an epiphysis. The lesion involves only a small portion of the longer bones. This includes the talus and calcaneum of Group I. Involvement of a joint is unlikely for a long time with an apophyseal lesion. Metaphyseal lesions can be primarily intracapsular, as in the neck of the femur. The nearer the lesion is to the joint surface, the earlier the extension to the capsule.

III. *Joint Lesions:* Joint tuberculosis rarely begins as a primary infection of the capsule. Usually the joint is infected by extension from a

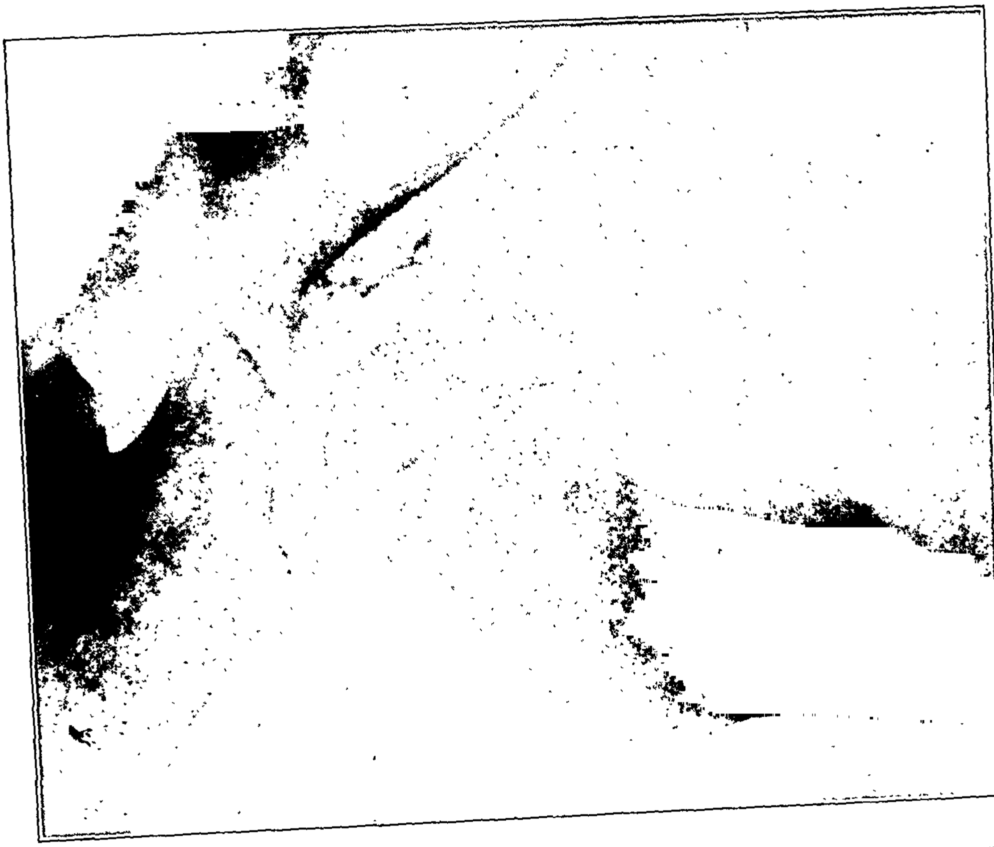

FIG. 1-B

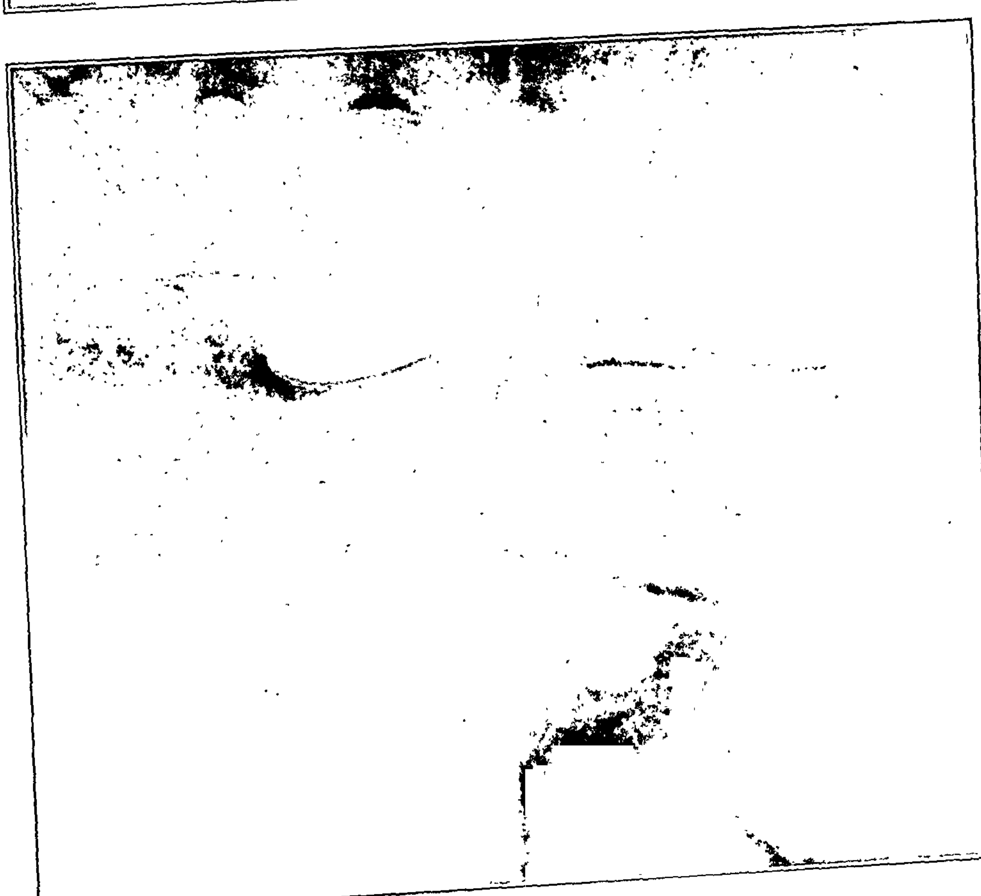

FIG. 1-A

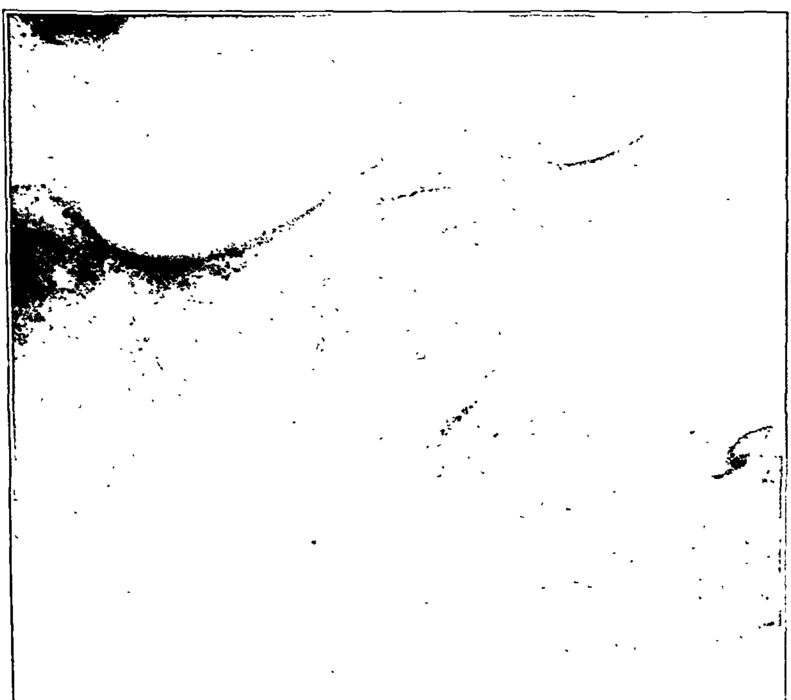

Fig. 1-C

Fig. 1-D

O. E., aged six years. Caries colli femoris intracapsularis; coxitis. Four roentgenograms taken on the same day, but in four different positions. In Fig. 1-A only one focus can be seen; while in Fig. 1-B two foci, in Fig. 1-C three, and in Fig. 1-D four separate foci are evident.

neighboring bone lesion. This extension is rapid in the case of the small bones of the wrist and foot, but years may elapse before it occurs in the larger bones and joints. The best illustration of primary infection of the capsule is in the knee joint.

If the lesion is entirely confined to bone, function remains normal for a long time. It is disturbed only if the supporting strength of the bone is diminished by extension of the lesion. The deposition of periosteal new bone in such cases proceeds very slowly. While the collapse of a long bone damaged by a tuberculous process is exceedingly rare, this usually occurs routinely in the vertebral bodies. Here the disease is first recognized by the change of form and not by inspection and palpation of the deep-seated lesion. In such cases, pain is a difficult symptom to evaluate because the patients are so rarely able to localize it accurately.

On the other hand, joint tuberculosis of long duration destroys the joint cartilage and, in the healing process, causes permanent loss of motion. Although most of these lesions are deep-seated and remain closed, they may, with rapid destruction and abscess formation, extend to the surrounding tissues and skin, rupture spontaneously, and form fistulae. The general condition gradually becomes worse because of secondary infection and delayed healing. If recovery occurs after the disease has been present for years, it is usually only an arrest or apparent healing. Lighting up of the process is still possible and late exacerbations are frequently observed. Rarely does complete healing occur.

TREATMENT

We require of every form of treatment: (1) that it shall be reasonably certain of securing healing of the tuberculous lesion and terminating the illness as soon as possible; (2) that it shall preserve the best possible function, and (3) that its cost shall not be prohibitive, but commensurate with the results obtained.

Therapeutic measures should always depend upon the general condition of the patient. General treatment to increase the resistance of the body to tuberculosis is fundamental. The local treatment of bone and joint tuberculosis is usually carried out according to the dictates of orthopaedic surgery, and consists essentially in rest and freedom from weight-bearing. Common practice has established the orthopaedic treatment as the method of choice even though it takes years to complete, the tuberculous focus remains in the body, and recovery with normal function practically never occurs. The loss of motion is taken for granted so that "complete ankylosis is the most desirable if not the ideal result of the treatment of a tuberculous joint lesion" (Putti 1934). The conservative treatment often does not represent, therefore, the *indicatio morbi*, the *indicatio orthopaedica*, or the *indicatio oeconomica!*

The requirements mentioned can be satisfied, in selected cases at least, by only one method of treatment,—namely, the radical surgical

treatment (Erlacher 1933), exemplified in the operative extirpation of the tuberculous focus (Waldenström 1908).

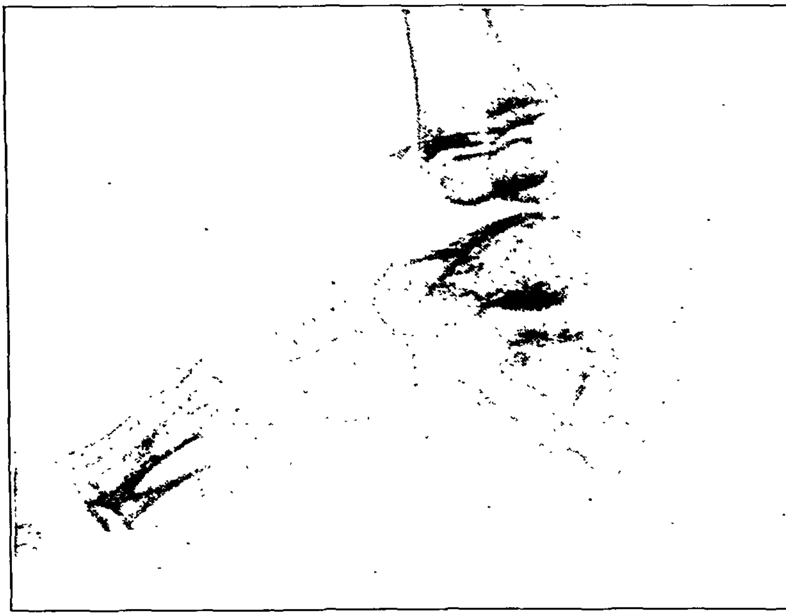

FIG. 2-A

FIG. 2-B

A. Kr., aged two years. Caries calcanei, with fistula; fungus pedis.
Fig. 2-A: roentgenogram, October 8, 1925. Extirpation of focus on October 20, 1925; iodoform paste. Lesion healed in February 1926. Duration of treatment, three and one-half months.
Fig. 2-B: roentgenogram, November 28, 1933, eight years after operation. Patient well, free from pain, with normal motion.

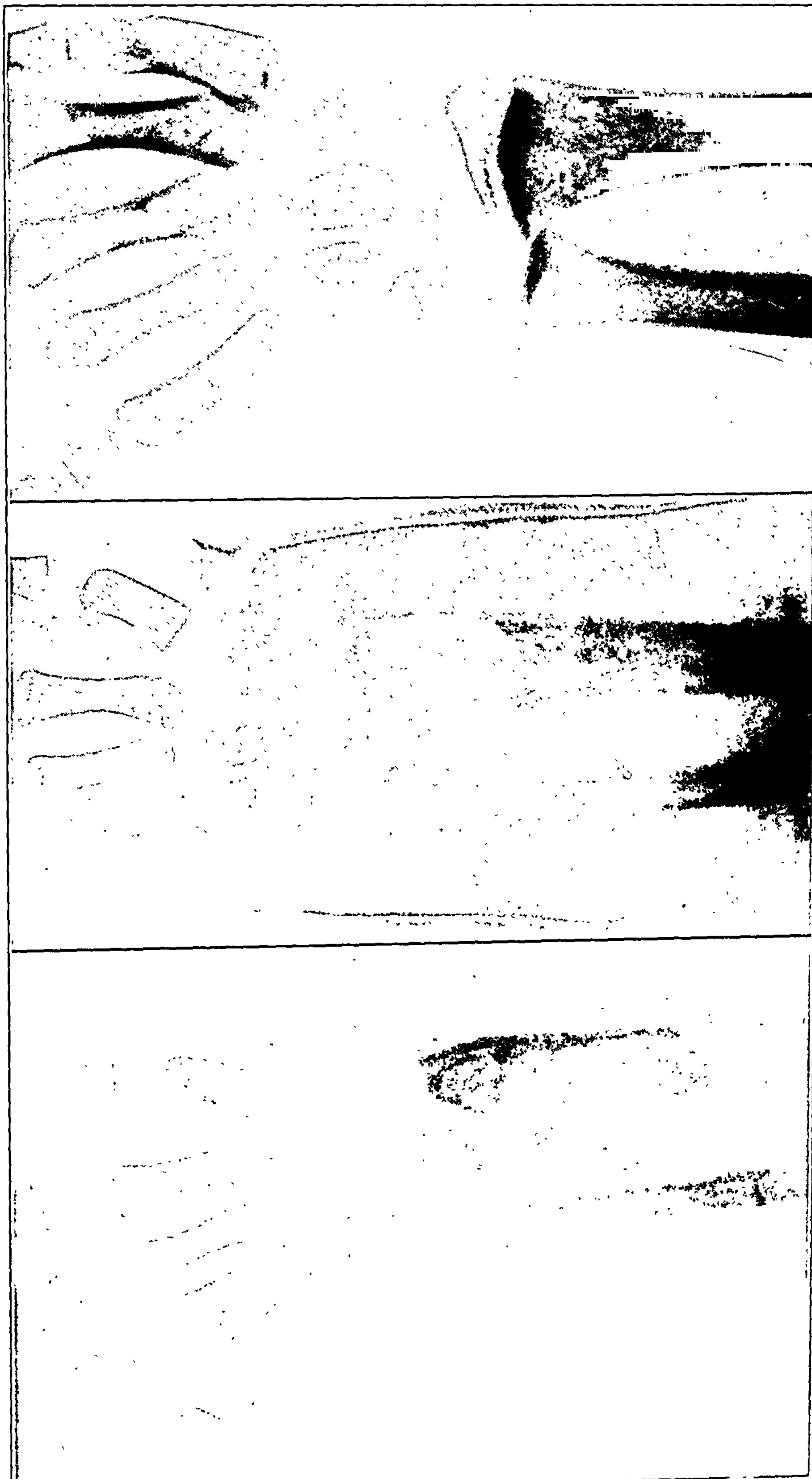

Fig. 3-A

Fig. 3-B

Fig. 3-C

FIG. 3-D

J. P., aged sixteen months. Caries radii (articulatio radii-ulnaris).
Fig. 3-A: April 8, 1930. Before operation.
Fig. 3-B: April 26, 1930. Immediately after operation (extirpation). Duration of treatment, two months.
Fig. 3-C: October 27, 1933. Three and one-half years after operation.
Fig. 3-D: Five years after operation. Lesion healed. Normal pronation and supination. Patient well and free from any disturbance.

The measures at our disposal must be classified according to their effects as: (1) those which combat the tuberculosis,—eradication and resection; and (2) those which only improve function,—arthrodesis and osteotomy.

Eradication of the focus can be carried out equally well at the so called "early" stage or at a late stage. It is the ideal radical operation. Unfortunately, it is not generally used because of the uncertainty of early diagnosis, the lack of experience in judging the status of the disease, and the clinical and roentgenographic difficulties in establishing the extent of the lesion. For this reason, only about 30 per cent. of the cases are suitable for extirpation. The blood picture and the sedimentation rate are valuable criteria. When all diagnostic aids verify the existence of a circumscribed tuberculous focus in the capsule or in the region of a joint, but not involving it, early eradication of the disease should certainly be attempted even though rupture into the joint threatens. The advantage of complete cure at one stroke is so great that one may with confidence assume the risks inevitably involved. At this point, we can stop the tuberculosis and preserve function. But even at a later stage, with the use of certain precautions, the removal of the diseased tissue may be accomplished and healing secured by the formation of a firm scar. Even then it is often possible to salvage useful motion. For extirpation, a rather extensive exposure is necessary; otherwise the operation consists of simple removal, preferably by electric cautery, of diseased, discolored, or softened tissue from the bone or capsule.

Resection is performed late in the disease. It consists in the extensive radical excision of the tuberculous region with deliberate abolition of joint function. It is a mutilating attack which would encroach on epiphyseal lines. It is justified only in adults. It must be so carried out that one accomplishes not only the wide excision of the tuberculous tissue, but later bony union of the resected surfaces.

Arthrodesis may be included in resection (intra-articular arthrodesis) when it serves also to cure the tuberculosis. More often it is a separate operation and so arranged that the tuberculous lesion is deliberately left undisturbed (extra-articular and extrafocal). Although this method is much in vogue today, it is fundamentally unsatisfactory. It does not spell defeat of the tuberculosis, but merely a compromise with it. It is the expression of our uncertainty, for we have let slip the most favorable opportunity for eradicating the lesion. Its action is purely mechanical and leaves undisturbed the tuberculosis which we are fighting. At any rate it has not been proved that the transplantation has a specific curative action on the disease process (Putti 1934). As we are taught by our experiences with vertebral tuberculosis in particular, the tuberculous process can advance in spite of successful fusion and go on to the invasion of new vertebrae or even to fracture of the graft (Odelberg-Johnson[1]). The almost universal overestimation of the value of extra-articular arthrodesis is, therefore, incomprehensible to the author, even though its usefulness in the isolated case is undoubted.

Osteotomy serves only to improve function through correction of position. It is a valuable and satisfactory operation in appropriate cases.

From all this, one must conclude that only extirpation and resection have great significance in the operative treatment of tuberculosis. And so emphasis has been placed especially on the value of extirpation which preserves function without mutilating and obliterates the tuberculosis. From personal experience the author can state that, with the exception of spinal tuberculosis, extirpation of the focus really decreases the duration

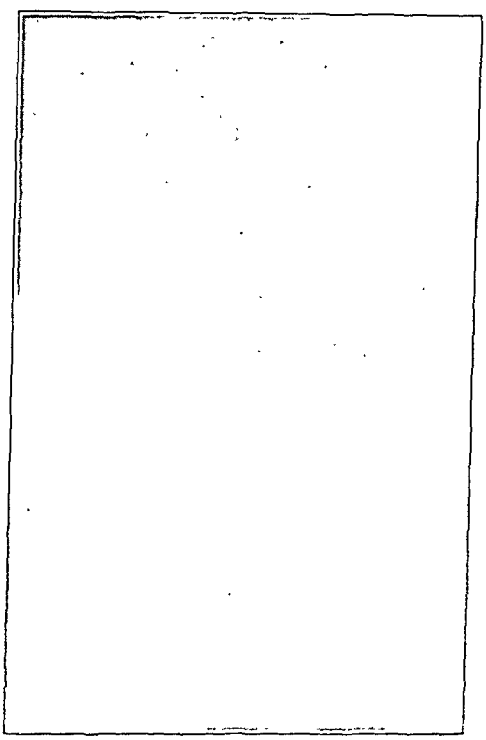

Fig. 4-A

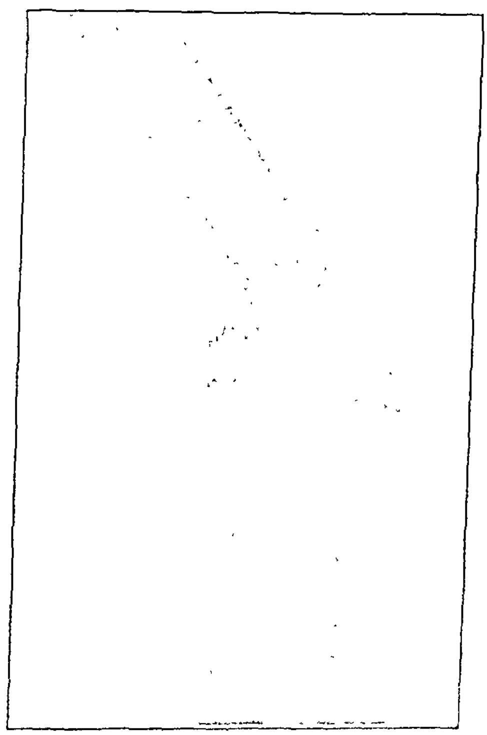

Fig. 4-B

of treatment of bone and joint tuberculosis by one-fourth or one-half. It leads to firm healing and in many cases preserves normal motion. Unfortunately either these facts are ignored or their practical application is doubted.

After the lesion has been classified as suggested, its adaptability for radical extirpation may be determined as follows:

I. (*Involvement of the Whole Bone with Secondary Invasion of the Joint*): In the case of a single lesion of a small bone of the hand or foot, it is best to remove the entire bone with the adjacent synovia which is usually also involved. Disturbance of function is hardly to be feared from the loss of this small bone. Three such cases treated by the author healed completely. An isolated lesion of the talus cannot be reached without opening a joint, but should be excised nevertheless (Sorrel). Access to the calcaneum is always possible. The synovia is not involved until late. The lesion should, therefore, be widely exposed and all tuberculous and devitalized tissue removed. Healing can then progress without disturbance of function. Of nine cases operated upon by the author, eight are healed and one has a persistent sinus (Fig. 2).

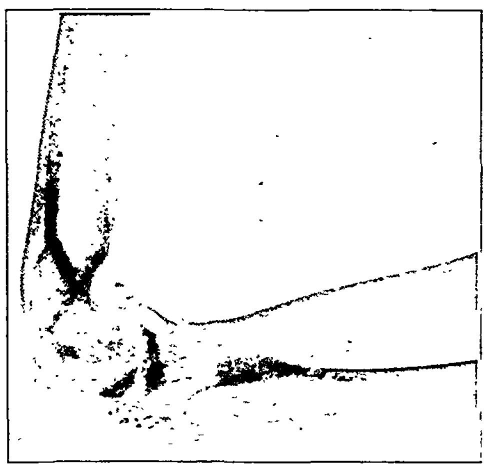

Fig. 4-D

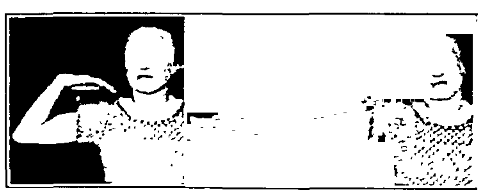

Fig. 4-C

Fig. 4-E

A. Z., aged six years. Caries fossae olecrani: fungus cubiti.
Fig. 4-A: February 15, 1921. Before operation.
Fig. 4-B: October 17, 1921. After operation (extirpation); iodoform paste. Duration of treatment, two months.
Fig. 4-C and Fig. 4-D: November 13, 1933. Twelve years after operation.
Fig. 4-E: March 12, 1935. Almost fourteen years later. Patient well, free from pain, and with normal function.

There is yet no sure and safe operation for tuberculosis of a vertebral body. A recent report from Japan[2] still offers no solution to this difficult problem.

FIG. 5-A

II-A. (*Involvement of the Diaphysis without Joint Invasion*): In diaphyseal lesions, one may limit himself to the radical removal of the tuberculous tissue. There is no contra-indication to thorough extirpation. One should proceed radically also on the cranial vault for the dura offers adequate protection against extension to the meninges. About the face, account should be taken of late contraction of scar tissue resulting from delayed healing. By almost complete removal of the scapula in the author's cases, the function of the arm was hardly affected. In all of the fifteen cases operated upon from this group healing took place.

II-B. (*Involvement of the Bone Ends; Epiphyseal Lesion with and without Joint Invasion*): A lesion occurring in the metaphysis or apophysis of a long bone may remain isolated many months after recognition without involvement of the neighboring joint. There is plenty of time for radical removal and healing without disturbance of function (Fig. 3). The joint capsule, however, often becomes involved from an epiphyseal lesion. Then, if it is necessary to open the joint to reach the lesion, there should be complete removal of the diseased capsule as well as of the bone lesion. The overwhelming fear of opening a joint in such a case is unfounded. Several times the writer has seen a clinically early lesion, such as a coxitis, in a patient with entirely free movement of the hip in which advanced tuberculous disease of the capsule could be demonstrated. If the infected capsule is not removed, the danger of a recurrence is great. Even if such a secondary synovitis does frequently disappear without ill effect, it seems that the thorough removal of the diseased capsule is the most reliable way to combat the tuberculosis and preserve motion. This is really recognized as:

III. (*Joint Lesions*): A purely synovial tuberculosis should be treated by synovectomy before the bony constituents of the joint are involved. The same holds for the occasional involvement of the ligamentum teres of the hip.

FIG. 5-B

F. P., aged one year. Caries tibiae; gonitis; flexion contracture.

Fig. 5-A: March 31, 1926. Before operation. Extirpation on April 28, 1926; iodoform paste. Duration of treatment, one month.

Fig. 5-B: October 20, 1934. Eight years after operation.

Fig. 5-C: Nine years after operation. Patient well with no pain, nor any disturbance.

FIG. 5-C

DISCUSSION

The author has excised purely metaphyseal foci only three times, and with good results. He has operated on metaphyseal and epiphyseal lesions next to large joints thirty-six times, including lesions near the ankle joint and two true cases of synovial tuberculosis. Of these patients, two subsequently died; healing took place in twenty with normal movement, in six with ankylosis which had been present before the operation, and in eight with preservation of limited motion (Figs. 4-6).

Of 276 cases of tuberculosis, there were ninety-two operations on sixty-eight patients with 110 circumscribed lesions. Since 1919, there have been only three deaths and only two cases in which healing did not result. In more than one-fourth of the cases, extirpation was possible. In two-fifths of these (forty-one cases), the operation was performed at an early stage; in three-fifths of them (sixty cases), at a late stage, but with good results.

Fig. 6-B

Fig. 6-A

H. P., aged five years. Caries colli femoris; synovitis tuberculosa; coxitis.

Fig. 6-A: August 7, 1933. Before operation. Following extirpation and drainage, treatment was continued for two months and the wound was healed on September 22, 1933.

Fig. 6-B: Roentgenogram showing condition on January 21, 1935.

Fig. 6-C: One and one-half years after operation. Patient well and free from pain with no functional disturbance.

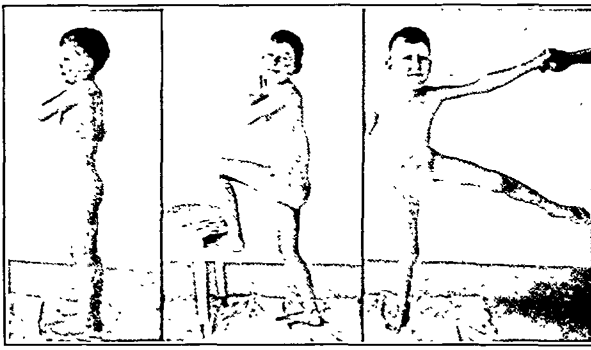

FIG. 6-C

Of the last group, six recovered with normal motion. Of the cures, ten cases were of more than ten years' duration; in twenty-six the duration was more than five years, and in thirty-four, four years. Following extirpation, even in cases with fistulae, the treatment is often concluded in three months and only rarely takes longer than six.

It should be noted that in all cases the diagnosis of tuberculosis was verified by histological study, animal inoculation, or by identification of the bacilli. With conservative treatment, the diagnosis is never certain and treatment takes two to six years or more. As yet there has been no recurrence in the author's cases.

To prevent any misunderstanding, the fact should again be emphasized that the radical operation should be performed only in cases of circumscribed, well demarcated lesions, and as early as possible. The operation is not dangerous and may preserve free motion. It should be tried also in borderline cases. The more one observes these, the more he comes to realize the indication for the radical operation in these cases also. Since the functional results are better than by any other method, wherever possible the early extirpation of the tuberculous focus is recommended.

SUMMARY

Inasmuch as the focus of tuberculosis in bone almost always begins as a small, isolated, circumscribed area, it should be removed by radical operation in this early stage whenever possible. Improved x-ray technique furnishes the justification for this procedure. The early extirpation of foci gives results which are obtainable by no other method of treatment, for it allows the rapid healing of the local tuberculosis and often preserves normal motion. This is demonstrated by the result of personal experience.

The cases shown in Figures 3, 4, 5, and 6 were presented on December 1, 1933, before the *Verein der Ärzte in Graz.*

1. ODELBERG-JOHNSON, G.: On Defects in the Bone-Graft after Albee's Operation for Tuberculosis Spondylitis. Acta. Orthop. Scandinavica, Supplementum I. 1934.
2. ITO, HIROMU; TSUCHIYA, JUNICHI; AND ASAMI, GOICHI: A New Radical Operation for Pott's Disease. Report of Ten Cases. J. Bone and Joint Surg., XVI, 499, July 1934.

TREATMENT OF GIANT-CELL TUMORS OF THE LONG BONES*

A. By Surgery; B. By Irradiation

BY CHARLES F. GESCHICKTER, M.D., BALTIMORE, MARYLAND

In the United States before 1910, the majority of giant-cell tumors were interpreted as sarcomata and treated as such. Afterward their recognition as benign tumors became more widespread, largely through the efforts of Dr. Bloodgood, and conservative surgery was advocated. During this period the most common treatment was curettage. In the past decade, as the benign nature of these tumors has become a more widespread conviction, treatment has passed from radical surgery to the other extreme of no surgery at all. At present, the prevailing types of treatments are curettage and irradiation. Whether surgery or irradiation will be employed depends largely upon the background of the medical center and physician instituting the treatment. From a purely personal standpoint, radiologists are apt to prefer irradiation and surgeons, surgery. It is the author's belief that a point has been reached where a middle ground can be taken between the two schools.

There are three groups of giant-cell tumors in which irradiation is preferable. The bone cyst on the shaft side of the epiphyseal line, with a short duration of symptoms, in young individuals may contain a great deal of giant-cell-tumor tissue. This is a so called giant-cell variant of the bone cyst. Irradiation is usually successful in accelerating healing and, where properly given, does not interfere with the growth of the epiphysis, in the writer's experience. In the second group of tumors in which irradiation is preferable, the patients are usually elderly adults, the tumor is seen relatively late, and there is pronounced destruction of bone. If a weight-bearing bone is involved, the probability of restoring the functions of the limb by surgery is doubtful. Irradiation should be tried first and, if unsuccessful, surgery remains as a second choice. When the giant-cell tumor is located in the spine, particularly in the lumbar or cervical region or in the skull in the region of the temporal fossa, irradiation is preferable to surgery. At such sites recurrence after surgery takes place in over one-third of the cases, and such recurrence is difficult to control and often fatal. For this reason, it is far better to rely upon initial irradiation. Surgery can be used following irradiation if the irradiation is properly given, whereas irradiation following unsuccessful surgery is usually without avail.

Surgery is preferable to irradiation in giant-cell tumors where the bone is not essential to the function of the limb. In such bones as the ulna and fibula, and rarely the rib, resection is the operation of choice

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, New York, N. Y., January 14, 1935.

and is practically never followed by recurrence. Surgery is also to be preferred in patients who are in middle life and in whom the function of the limb is vital to their occupation and livelihood. Irradiation is far slower in its effects and disables these patients for too long a time. Finally, surgery is preferable in cases in which the initial treatment has been given elsewhere and where, because of inadequate excision, incision, or irradiation, there is recurrence. Irradiation in such secondary cases (particularly following a primary unsuccessful operation) rarely secures good results.

Four important factors should be considered by the practitioner before proceeding with treatment in any case of suspected giant-cell tumor:

First, there is the question as to the possibility of making an accurate diagnosis in the absence of biopsy. If the x-ray picture is not typical of giant-cell tumor, the chances are against such a diagnosis, but the reverse is not always true. All bone tumors giving a picture typical of giant-cell tumor in the roentgenogram do not prove to be benign giant-cell tumors on microscopic examination.

Second, before proceeding with surgery, the determination of the amount of healthy active bone available is important. It is not advisable to proceed too far with surgery, particularly in elderly adults, when there is not enough uninvolved bone remaining to bear the weight of the limb.

Third, one must bear in mind the importance of the involved bone with respect to the function of the limb. Conservative surgery or irradiation should not be persisted in to save a bone such as a metacarpal, the ulna, or the fibula.

Fourth, the possibility of performing a thorough surgical removal of the lesion, without impairment of function, should outweigh all other considerations. In a follow-up of 300 cases treated by various methods, the percentage of successful results was highest where resection had been performed.

THE ASSOCIATION OF INTRATHORACIC LESIONS WITH BONE AND JOINT TUBERCULOSIS

A Study of 100 Cases

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Opinions regarding the frequency of the association of intrathoracic lesions with bone and joint tuberculosis differ. Some statements have been based on clinical examinations of the chest alone, while others have been substantiated by roentgenographic evidence. Alwens and Flesch-Thebesius, in a study of 100 children with bone and joint tuberculosis, demonstrated evidence of pulmonary lesions in 53 per cent., and of these 7 per cent. showed lesions of the tracheobronchial lymph glands. On the other hand, among 100 cases of tuberculous hip disease in children, Bowlby was able to find pulmonary lesions in only six cases. MacKinnon, from a study of thirty cases, concluded that in a majority of adults suffering from bone and joint tuberculosis evidence of a coexisting pulmonary infection could be demonstrated; whereas Keller found only four patients with pulmonary lesions in a series of forty-six cases of bone and joint tuberculosis.

Hibbs and Risser, in a paper dealing with 286 cases of spinal fusion for tuberculosis, reported pulmonary lesions in only five instances. They stated: "It would seem that the number of cases of pulmonary tuberculosis discovered before operation is too low, and that had more expert physical examination been made and x-rays taken, more cases would have been discovered." Lo Grasso has emphasized that "We must not lose sight of the fact that 65 per cent. of bone and joint cases have pulmonary lesions also, and most of the deaths that take place following operation or even following heliotherapy are due, not to the local lesion, but to pulmonary tuberculosis." In a study of 437 cases he found 40 per cent., including children, with a clinically diagnosed pulmonary lesion.

Ragolsky in a study of 200 consecutive roentgenograms of the chest in cases of surgical tuberculosis concluded that in approximately one case out of every six (17.5 per cent.) there was bona-fide pulmonary tuberculosis. Of the rest, 55 per cent. showed intrathoracic lesions not necessarily active. Snyder has found pulmonary lesions in 40 per cent. of 100 substantiated cases of bone and joint tuberculosis. His data also are based on roentgenographic findings.

The committee appointed by the American Orthopaedic Association to evaluate the end results of the treatment of joint tuberculosis reported in 1933 as follows: "Fatal joint or osseous tuberculosis without active pulmonary disease is not uncommon. Of the fatal cases, 37 per cent. showed active pulmonary disease; while 63 per cent. did not present pul-

monary disease of any consequence." This report is based on 148 deaths from 811 cases collected from the clinics of Dr. F. C. Kidner, Dr. E. G. Brackett, and Dr. Emil Geist, and also cases treated in the Lakeville State Sanatorium.

Data may differ as to the percentage of cases of bone and joint tuberculosis that are complicated by coexisting intrathoracic lesions, active or otherwise, but it is a well accepted fact that bone and joint tuberculosis is never primary. It is always a secondary manifestation of a general disease, the primary focus of which lies elsewhere. The majority of the

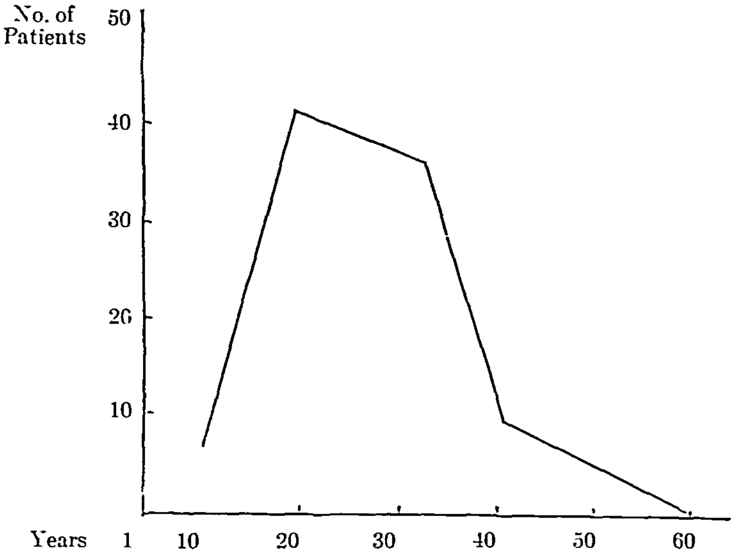

FIG. 1

Chart showing the frequency of the onset of bone and joint tuberculosis in various age periods.

cases studied in this paper gave evidence of the involvement of either the lungs or the tracheobronchial lymph glands, and the data seem to agree very well with those obtained by Snyder.

This study is based upon a review of the records of 100 in-patients, treated on the orthopaedic service of the Peiping Union Medical College Hospital during the past three and one-half years, of whom consecutive roentgenograms of the chest were taken. The cases in which there was no roentgenographic check-up of the chest in addition to a routine clinical examination were not included, although pathologically the surgical condition may have been proved to be tuberculous.

Of the 100 patients, fifty-two were female and forty-eight male. All were Chinese with the exception of one patient whose mother was a Russian. The youngest patient was nine years old at the time of admission and the oldest was fifty-six. The average age of the patients was 22.66 years. *Figure 1 shows that in 41 per cent. of the patients the onset of the* disease occurred in the second decade of life and in 37 per cent. the onset

took place in the third decade. There was a rapid decline of incidence after the fourth decade. The duration of the disease before the patients applied for treatment varied from one month to twelve years, averaging for the total series 25.02 months.

Discharging sinuses led the list of complications. They were present in 66 per cent. of the cases and influenced greatly the treatment as well as the prognosis in individual cases. As a rule, the presence of such sinuses signified two important factors which should be appreciated. The first factor was a poor economic condition. These patients had delayed applying for treatment until sinuses had formed. Furthermore, they usually could not afford proper postoperative care. The second factor was ignorance. A large number of the patients had tried many kinds of cheap, falsely advertised local applications before they came to the hospital, so that the sinuses and the deep structures were found to be already frankly infected with secondary organisms and the general condition of the patients was such that it was necessary to be more immediately concerned with the saving of life than with the local conditions. Therefore, it is not surprising to find that 55 per cent. of the cases were treated by amputation and that arthrodeses were carried out in only eleven instances.

Tuberculosis of the lymph glands, tracheobronchial glands excluded, was noticed seventeen times, while the list of complications included tuberculosis of the intestines and peritoneum (four cases), of the kidney and urinary bladder (two cases), of the skin of the face (two cases), and of the epididymis, eye, soft tissues of the arm, and of the breast (each one case).

In the cases reported in this paper, the diagnosis of tuberculosis was substantiated by pathological section in ninety-six instances. In the remaining four cases, specimens were not obtained. One of these was a case of tuberculosis of the elbow in which the triceps tendon was tenotomized in order that the elbow might be immobilized in a more flexed position. The second case was that of a girl sixteen years old who had a tuberculous hip and multiple healed sinuses for which she had received treatment in a sanatorium for eight years. The hip had become ankylosed in a marked adduction and flexion deformity, and, for this reason, a subtrochanteric osteotomy was performed. The other two cases were patients with tuberculosis of the spine. Although pathological proof was lacking in these four cases, it was considered that the clinical histories and the roentgenographic findings furnished sufficient reason to include them in this study.

For convenience of study, the patients were divided into five groups according to the type of chest findings reported by the roentgenologists. Type I includes those patients reported as showing "normal chests" "lungs clear", "only pleural thickening", and "no frank tuberculosis in lungs". Type II includes those reported as showing "hilum tuberculosis" and "increased hilum with calcified tracheobronchial glands". Type *III* includes those reported as "juvenile tuberculosis with involvement of

adjacent parenchyma", "minimal tuberculosis", and in one case "old tuberculosis". Type IV denotes "moderately advanced tuberculosis" and Type V signifies "advanced tuberculosis". It will be noticed that the last three types represent definite parenchymatous lesions, active or old, minimal or extensive, and only in the first type is there no actual intrathoracic lesion. It may be stated here that this study was not so much concerned with the degree of the activity and extent of the lesion in the chest as with the existence or non-existence of an intrathoracic lesion.

From the 100 consecutive x-ray reports, fifty cases were assembled that would naturally be classified under Type I. However, in order to determine the percentage of cases in which there were actual intrathoracic lesions, it was considered necessary to review carefully all of the chest films of each patient in this series. With the collaboration of Dr. T. T. Wang, of the Tuberculosis Service, it was possible to study the chest films of eighty-eight cases; those of the remaining twelve cases were not available. Of the eighty-eight chest roentgenograms studied, forty-three belonged to Type I according to the reports. Of this latter number, however, twenty-eight showed calcified tuberculous tracheobronchial lymph glands. Taking this data into consideration, the following tables were prepared.

TABLE I

ANALYSIS OF CASES OF A SINGLE SURGICAL LESION

Site of Lesion	Type of Chest					Total
	I	II	III	IV	V	
Bones of foot and ankle	6	10	7	4	0	27
Hand and wrist	1	3	2	3	0	9
Femur	1	0	0	0	0	1
Tibia	0	2	2	1	0	5
Humerus	0	0	1	0	0	1
Scapula	3	0	0	0	0	3
Clavicle	0	0	1	0	0	1
Pelvis	0	1	0	0	0	1
Spine	0	3	3	0	0	6
Hip	0	1	0	0	0	1
Knee	3	3	2	7	1	16
Shoulder	0	0	1	0	0	1
Elbow	1	2	3	1	0	7
Total	15	25	22	16	1	79

From Table I it is apparent that of seventy-nine patients with a single surgical lesion thirty-nine, or 49.4 per cent., showed definite involvement of the lung, and twenty-five, or 31.6 per cent., had tuberculosis of the hilum. From Table II it is evident that of twenty-one patients with multiple surgical lesions only eight (38.1 per cent.) showed pulmonary in-

TABLE II

ANALYSIS OF CASES WITH MULTIPLE SURGICAL LESIONS

Site of Lesions	Type of Chest				Total
	I	II	III	IV	
Right elbow and right thumb	1				
Left ulna and left middle finger	1				
Right knee and right wrist	1				
Left hip and left ankle	1				
Right foot and left hand				1	
Right foot and left hand		1			
Left heel and left big toe	1				
Right foot and left ulna		1			
Right ulna, left tibia, and left fibula			1		
Left elbow, left hand, and left foot				1	
Left heel and left thumb		1			
Right radius and right knee	1				
Clavicle, spine, and left hand		1			
Right elbow, right hand, left ankle, and rib		1			
Both hands				1	
Cervical spine and sixth rib			1		
Right elbow and scapula			1		
Right knee and left hand			1		
Left knee and left radius		1			
Right hand, lumbosacral and sacro-iliac joints			1		
Right heel and left wrist	1				
Total	7	6	5	3	21

volvement and six (28.57 per cent.) had tuberculosis of the hilum. Comparing the second table with the first, it is obvious that in this series patients with a multiplicity of surgical lesions did not necessarily show a coexisting pulmonary lesion of a more severe type.

One also notices that instances of tuberculosis of the lower extremities numbered fifty as against eighteen cases in which there was involvement of the upper extremities. It seems obvious that the lower extremities are exposed to injury more often than the upper extremities. Although injuries do not cause tuberculosis, most authorities concur in believing that local injuries may precipitate the lesion in tuberculous individuals. Furthermore, pressure and motion between the articular surfaces during the act of weight-bearing (as in the case of the lower extremities) are distinctly detrimental to a joint already infected. Also, it was observed that cases of tuberculosis of the knees often presented more evidence of severe pulmonary involvement than cases in which other joints were involved.

Of the 100 patients, seventy-eight showed evidence of intrathoracic lesions; of these, forty-seven had bona-fide pulmonary tuberculosis. Only twenty-two of the 100 patients (including twelve cases in which

chest films were not available) presented no lesion at all. It should be stated, however, that negative roentgenograms do not rule out tuberculous lymph glands which are not yet calcified.

There were four deaths in this group of cases. All of the four patients had bona-fide pulmonary lesions, three belonging to Type III and one to Type V. The local lesions involved the knee joint in two cases, the ankle in one case, and the hand, lumbosacral and sacro-iliac joints in the fourth case. In one case, the condition of the lungs became so much worse shortly after operation that the patient soon succumbed to the disease. In the other three cases, there was a complicating tuberculosis of the intestines and peritoneum in each instance, and in one case also a tuberculous mastitis. It is to be noted that in none of the fatal cases was the chest free from a tuberculous lesion.

Furthermore, one has no right to say that a patient has been cured of tuberculosis even though the diseased parts have been amputated. A girl, sixteen years old, had extensive tuberculosis of the left wrist for five months. The chest films showed only calcified tracheobronchial glands. The hand was amputated and the wound healed *per primum*. Two and one-half years later, she developed tuberculosis of the other arm. Another girl, twenty-five years of age, suffered from tuberculosis of the left elbow for one and one-half years. The chest films showed only minimum tuberculosis of both upper lobes. The arm was amputated, but six months later tuberculosis of the intestines and peritoneum developed. Similar cases are common. We do not mean to condemn amputation as a proper procedure in the case of extensively involved extremities. In fact, we feel strongly in accordance with Stearns that amputation is often the best procedure for many of these cases. Only by this means can we expect the patients, who have been on the verge of exhaustion from pain and the lack of sleep, to be able to secure both the mental and physical rest necessary for recuperation.

Treatment, however, should not be discontinued when the peripheral lesions have been eliminated. Our efforts should be further directed toward the primary focus. We believe that practically all of our cases are infected by the human type of tubercle bacillus. As a rule, the Chinese do not drink cows' milk. Therefore, the bovine type of tubercle bacillus which has been held responsible for tuberculosis of lymph glands and bones in the children of other countries does not seem as yet to be a complicating factor in China. Granting that a certain number of the patients may have the primary focus in the intestinal lymph glands, following ingestion of food contaminated by human tubercular bacilli, still the tubercular bacilli must find their way into the right side of the heart and thence to the lungs before they reach, through the blood stream, the more distant parts of the body such as the bones and joints of the extremities. We admit that the primary focus is often very difficult to determine, but, in view of the data collected from this small series of cases, we believe that possible intrathoracic lesions should receive more careful attention.

CONCLUSIONS

The relation between intrathoracic lesions and bone and joint tuberculosis is a close one. Of 100 patients suffering from bone and joint tuberculosis, the chest films showed pulmonary involvement in 47 per cent. and intrathoracic lesions of varying degrees in 78 per cent. In view of such a high percentage, more attention should be paid to intrathoracic infections as the probable primary foci of so called surgical tuberculosis. A multiplicity of surgical lesions, however, does not necessarily bear any direct relationship to the extent of the existing pulmonary infection.

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THE TREATMENT OF ACUTE PURULENT ARTHRITIS BY JOINT WASHING AND CLOSURE*

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Septic joints have rudely demanded the attention of surgeons in the past, instilling dread because of many disasters. Stiff joints and deformities frequently have resulted and death too often has been the outcome. The care of these cases has been an unpleasant duty, particularly because the surgeon is concerned as to whether or not he has carried out the best possible type of treatment. A search through the literature leaves one still undecided as to the best method inasmuch as such diametrically opposite types of treatment are recommended.

In a recent symposium on acute suppurative arthritis, presented before the Royal Society of Medicine, very divergent views are expressed by eminent English surgeons.[1] Likewise, in the United States, recommendations as to treatment vary decidedly.

If the experiences and opinions expressed in the literature are followed for guidance in the treatment of purulent joints, there is a choice between several different procedures, as follows:

1. Drainage and active mobilization (Willems[2]);
2. Drainage, immobilization, and traction (Harris[3]);
3. Joint washing, closure of the joint, and temporary immobilization (Cotton[4, 5]).

Prompted by the satisfactory experience of Dr. Ellis Jones with the joint-washing treatment described by Cotton in 1916 and 1920, the author has used this type of treatment in a limited number of cases. The surprisingly good results have borne out the contentions expressed by Cotton and Reich[6] in their articles; therefore, the writer has thought it worth while to report his cases together with the recent cases of Dr. Ellis Jones.

TECHNIQUE

The technique followed in treatment has been essentially that described by Cotton. After aspiration of the joint has given evidence of a purulent effusion and general as well as local symptoms have indicated more than a mild effusion, an incision is made into the joint. In the case of a knee, the incision is about one inch long, vertical, and to one side of the proximal part of the patella. The appearance of the joint lining and the fluid is noted. Next, the joint is washed out as carefully and as thoroughly as possible with normal saline solution at 110 degrees, delivered through a catheter under moderate gravity pressure, for a period of from twenty to thirty minutes. The joint is permitted to fill with fluid like a

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balloon and then to collapse, whereupon the fluid is allowed to escape, carrying away pus, fibrin, and other débris. An attempt is made to gain a water-tight closure of synovial membrane and capsule. Usually the skin also is closed. A cast is applied to afford joint rest and the progress is measured by noting the patient's general condition, the temperature, pulse, respiration, blood picture, and urinary findings, as well as local symptoms and signs in the knee.

Cotton has used a 1 to 15,000 solution of bichloride in saline for the irrigating fluid. Recently[8], he has reemphasized the point that he does not advise the joint washing when a bone lesion communicates with the joint, or when the inflammatory process has gone on to synovial destruction. For the complicated cases, he states that he knows of nothing better than the Willems technique.

If signs of unfavorable change are evident in the succeeding days and inspection of the joint reveals considerable effusion into the joint, another washing is done. Guarded motion is begun when the acute symptoms in the joint have subsided; in certain cases, such motion has been started as early as ten days after the washing of the joint. A careful search is made for the source of the infection. Septic teeth, septic tonsils, and gonorrhoea have been blamed most frequently. An extreme infection of the gums by Vincent's angina has been looked on with much suspicion. One must be ever on the alert for a focus of osteomyelitis associated with a septic joint, and at times not only very careful observation, but also a portion of good luck seem necessary in order to rule out the osteomyelitis and to be correct in the decision.

REPORT OF CASES*

CASE 1. H. M. A., a man, aged thirty-nine years, was seen because of an extremely swollen left knee joint.

In May 1930, the left knee had been twisted when acutely flexed and trouble had developed, with a fever of 102 degrees, requiring a week or ten days in bed. In June 1930, a like injury had caused similar trouble. In July 1930, twenty cubic centimeters of amber-colored fluid had been aspirated. On August 22, 1930, the knee had suddenly begun to pain severely and the temperature had risen.

At examination on August 23, 1930, the temperature was 103.2 degrees; the pulse rate, 100; and the respiration rate, 20. The left knee was tensely swollen, the suprapatellar pouch was distended, and the thigh was tender in the lower third; these symptoms made the author suspect early osteomyelitis. Septic tonsils and infected teeth were present.

A roentgenogram (Fig. 1), taken on August 23, 1930, showed negative shadows, but signs of soft-tissue swelling and a floating patella, indicating fluid in the joint; areas of decreased density behind the distal third of the femur suggested the possibility of an abscess.

The leukocyte count was 14,500 with 81 per cent. polymorphonuclear leukocytes before operation. A diagnosis of acute purulent arthritis of the left knee joint was made.

Joint washing was performed for thirty minutes on the day of examination. An

* Cases 1, 2, and 3 are the author's patients. The remaining cases are patients of Dr. Ellis Jones. Indebtedness is also acknowledged to Dr. LeRoy C. Abbott for a portion of the case records in Case 8.

anteromedial incision released a large quantity of fibrinous fluid containing much mucus and débris. The synovial villi were dark red in color and swollen. After this wound had been carefully closed, gloves and instruments were changed and a new field was prepared for incision on the lateral surface of the lower thigh. No pus nor sign of inflammation was found here, so the femur was not opened and this wound was closed. A cast was applied from toes to groin and split bilaterally.

A smear of the fluid from the joint showed numerous pus cells, but no bacteria were evident. The culture was negative.

On the day after operation, the patient felt much better. He improved steadily and the temperature range was normal after the fourth day. Twelve days after operation the cast was removed for the first time, but the posterior half was used at night for a while longer. Thirteen days after operation, an infected tooth was extracted from which cultures of streptococcus viridans and staphylococcus were recovered. Twenty-five days after the operation on the knee, a tonsillectomy was performed.

On September 30, 1930, the patient had been at work, and slight fluid was present. He was wearing an elastic stocking. On October 24, 1930, full extension and 15 degrees' limitation of flexion were present. On April 10, 1933, the patient stated in a letter that the knee was as nearly normal as it ever had been.

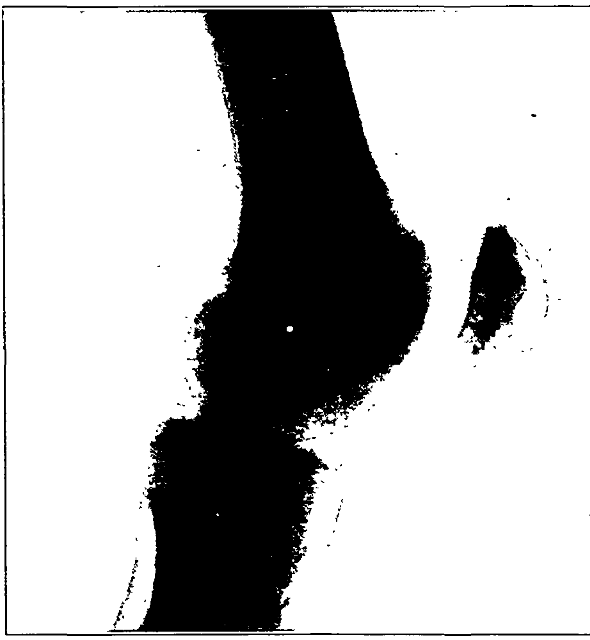

FIG. 1

Case 1. Roentgenogram of left knee joint, August 23, 1930, before joint washing. Note evidence of distention of the suprapatellar pouch, the floating patella, and the negative bone shadows.

CASE 2. B. G., a boy, aged three and one-half years, was first seen on December 16, 1931, with osteomyelitis of the right upper tibia. Active symptoms had been present over night. His temperature was 102.6 degrees; the pulse rate, 120; and the leukocyte count, 19,200.

There was a history of a bump on the region of the knee two days before. A probable focus was an infected deciduous tooth that had been drilled two or three months previously to relieve an abscess. Several weeks after the drilling, when the inflammatory process at the root of the tooth seemed to have quieted down, the hole in the tooth was filled.

On the day of examination, the upper tibia was explored and a window, chiseled through the cortex, released pus under pressure. A vaselin pack was loosely inserted and a plaster cast was applied. The culture of the pus yielded staphylococcus aureus. The deciduous tooth in question was easily lifted out. It was found to be badly eroded and the labial bone was absent from the maxilla, due to erosion.

The patient did not improve as expected and, on December 26, 1931, ten days after the operation, the roentgenogram (Fig. 2) gave evidence of a distended knee joint.

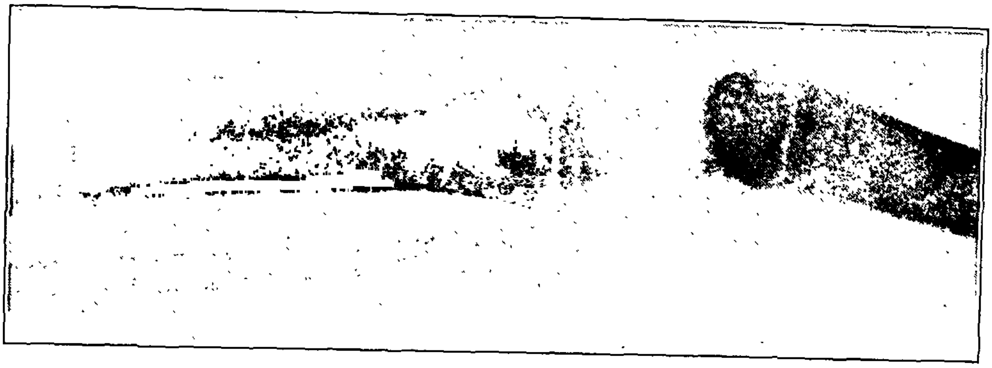

FIG. 2

Case 2. Roentgenogram of the right knee joint, December 26, 1931, ten days after the primary operation for osteomyelitis of the tibia and just before the first joint washing. Note the evidence of joint distention, as well as the signs of destruction in the proximal part of the tibial shaft.

FIG. 3

Case 2. Roentgenogram, December 30, 1931, just before the second joint washing. Note the evidence of joint distention and more marked destruction in the tibia.

FIG. 4

Case 2. Roentgenogram, January 5, 1932, indicating the radical removal of bone from the tibia at the operation of December 30, 1931.

A smear of the yellow, cloudy fluid which was aspirated showed gram-positive cocci and pus cells.

Through an anterolateral incision above the patella a large quantity of fibrinous material and fluid was removed, and the joint was washed out with warm, normal saline solution for at least thirty minutes before closure of the joint and skin. The soft-tissue wound over the osteomyelitic tibia was enlarged to provide freer drainage from the tibia. The bivalved cast was reapplied. Staphylococcus aureus was recovered by culture of the fluid from the knee.

The temperature continued high and reached 105 degrees on December 29, 1931; the leukocyte count rose to 23,150.

On December 30, 1931, the roentgenogram (Fig. 3) again indicated distention of the joint and joint washing was again performed for fifteen minutes. At this time the capsule alone was carefully sutured and the skin wound left open. It was the author's belief that inadequate drainage from the tibia had caused the pus to drain back into the joint; therefore, the tibial wound was attacked as quickly as possible and the bone was radically removed (Fig. 4) in the hope of effecting very free drainage from the tibia. A loose vaselin pack was inserted and the posterior half of the cast was used as a splint. After two days, recovery was rapid. The cast and vaselin-pack treatments were continued until March 29, 1932, when the cast was removed. Then a walking caliper brace was used for four months, during which time free motion developed.

FIG. 5-A

FIG. 5-B

Case 2. Showing the range of active motion in the right knee joint about twenty-seven months after joint washing.

The patient developed full range of knee motion (Figs. 5-A and 5-B) and the tibial wound also healed some months later, after a conservative plastic operation on January 18, 1933. For a week in January 1934, the upper tibia became moderately tender and there was slight temperature elevation, but the knee did not swell. The process, evidently an exacerbation of the old osteomyelitis of the tibia, quieted with rest in bed. Moderate knock-knee has developed with an increase in length of the right tibia.

CASE 3. M. T., a woman, aged forty-five years, a domestic, was first seen on April 27, 1932, because of a painful left shoulder joint.

Two weeks before admission, she had had a sore throat. After this, she had done

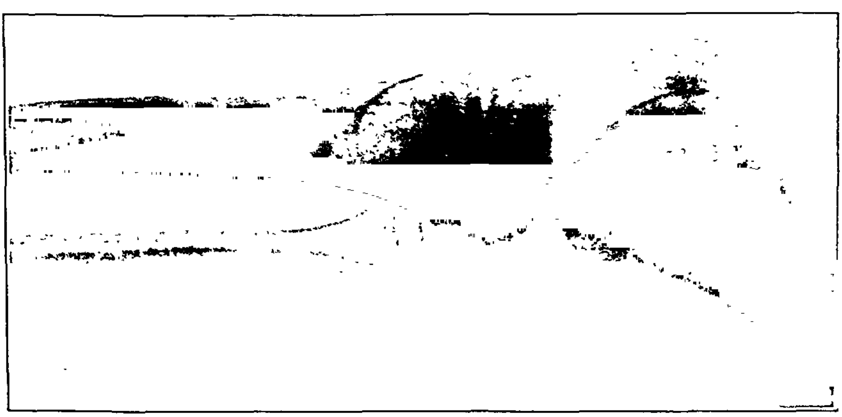

FIG. 6

Case 2. Roentgenogram, April 27, 1934. Note the signs of repair in the tibia and the appearance of the joint space.

much sweeping, and the trouble in the left shoulder seemed to start with the excessive use of the arms.

At examination, the temperature was 101 degrees and the pulse rate was 108. The left shoulder was tender and any motion caused pain. The tonsils were deeply pitted and showed signs of inflammation. The roentgenogram (Fig. 7), taken on April 27, 1932, showed marked downward displacement of the humeral head. This was interpreted to mean a joint effusion. The leukocyte count was 18,800, the polymorphonuclear leukocytes numbering 82 per cent. on the day of operation. A diagnosis of septic arthritis of the left shoulder joint was made.

The shoulder was opened anteriorly on April 27, 1932, and the humeral head was found displaced downward, but it was surprising to find no great amount of fluid present. The synovial membrane presented villi, two of which were excised for study. The joint was washed for a period of half an hour with warm, normal saline solution and closed in layers. An aeroplane cast was applied.

Sections of excised tissue showed oedematous tissue with numerous wandering cells, principally polymorphonuclear leukocytes. The culture taken from the shoulder grew staphylococcus albus. Five days after the operation, removal of the stitches released free pus. Culture of the pus produced a growth of staphylococcus aureus. A very limited range of motion developed.

Case 4. W. M., a man, aged thirty years, reported on March 10, 1930, complaining of a swollen, disabled right knee joint.

Bumping of the right knee on December 29, 1928, had produced aching which had lasted a week. An effusion had developed and aspiration had been done, but the slight effusion had continued. Two days before registration the knee had become badly swollen, necessitating the use of crutches.

At examination on March 10, 1930, a massive effusion was present. The temperature was 99.8 degrees; the pulse rate, 88; and the leukocyte count, 5,000, with 66.5 per

Fig. 7

Case 3. Roentgenogram of left shoulder joint taken on April 27, 1932, just before joint exploration. Note the downward displacement of the humeral head caused by loss of the normal negative pressure within the joint.

cent. polymorphonuclears. The tonsils were large and septic. Bilateral cervical lymph nodes were tender. Marked pyorrhoea and the appearance of Vincent's angina prompted examination of a smear from the gums, which was positive for the Vincent types of organisms. The roentgenogram (Fig. 8) indicated soft-tissue swelling and increased density, suggesting an effusion within the knee joint.

On March 11, 1930, aspiration of the knee joint yielded thick, yellow fluid containing pus, masses of fibrin, and coagulated material. The joint was washed for a period of thirty minutes and the wound was closed in layers. A smear of the fluid from the knee showed numerous pus cells and mononuclear cells. No bacteria were seen.

The temperature was normal on and after the fifth postoperative day. The Vincent's infection of the gums was treated and tonsillectomy was performed on March 18, 1930. During the succeeding six months, general treatment for arthritis and local physiotherapy were given. In July and August 1930, the opposite knee presented an effusion, but surgery was not necessary. In October 1930, the patient was discharged with normal function in the knee.

Fig. 8

Case 4. Roentgenogram of right knee joint, March 10, 1930. Note signs of soft-tissue swelling and increased density suggestive of a joint effusion.

Case 5. F. H., a man, aged forty-five years, presented himself for examination on September 9, 1930, because of an acutely painful right shoulder.

For a period of two years, the patient had had trouble of a mild degree in the right shoulder. On September 1, 1930, an abscessed tooth had been removed and, while this was still draining, an osteopath had manipulated the shoulder. Excruciating pain had developed on the following day, and the patient had taken eighty grains of aspirin without relief.

On September 9, 1930, palpation of the shoulder indicated that the capsule of the right shoulder joint was grossly distended and filled with fluid. The temperature was 100.4 degrees; the pulse rate, 100; and the respiration rate, 24. The leukocyte count was 13,400, with 72.5 per cent. polymorphonuclear leukocytes. A roentgenogram of the shoulder showed a zone of decreased density, indicating a joint effusion. A diagnosis of acute purulent arthritis of the right shoulder joint was made.

On the day of examination, the shoulder joint was opened and the synovial membrane was found to be thickened and the color of a strawberry. The routine irrigation and closure were done. A smear of the joint fluid showed a few pus cells, but no bacteria were evident. Culture produced a few colonies of staphylococci aurei.

The postoperative temperature range was normal on the second day and thereafter. Almost complete function of the shoulder developed. The patient had been an ardent tennis player for years and, when last seen on April 26, 1934, he said that he had experienced no difficulty in playing. Figure 9 shows the amount of motion in the right shoulder joint in May 1934.

CASE 6. J. G., a man, aged twenty years, was seen first on November 5, 1926, with a history of gonorrhoeal urethritis.

Two weeks previously, the knee had been struck, and disability compensation for an industrial accident had been claimed by the patient.

On November 3, 1926, aspiration had been done and pus had been found.

The patient's general appearance was that of a sick person. The temperature was 102.8 degrees. The knee joint was greatly distended. A diagnosis of acute purulent gonorrhoeal arthritis of the knee joint was made.

On November 5, 1926, arthrotomy, irrigation, and closure were done. Cloudy, flocculent fluid, with much fibrin, was evacuated. Traction of ten pounds was applied to the leg. A smear of joint fluid showed numerous pus cells, but no bacteria were seen. The material for culture was old before planting and incubation, and no organisms grew.

On March 25, 1927, the range of motion was 160 degrees to 50 degrees.

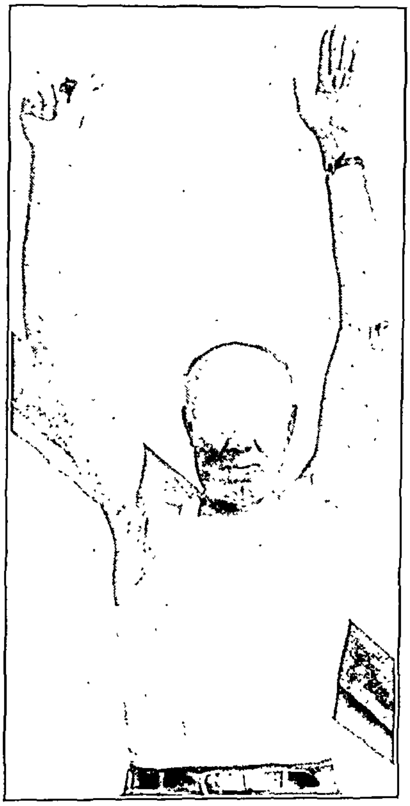

FIG. 9

Case 5. Photograph taken in May 1934, indicating motion possible in the right shoulder joint three years and eight months after operation.

CASE 7. T. L., a boy, aged thirteen years, was brought for examination on September 5, 1933, because of an acutely painful, swollen right knee joint.

The patient's general health had been good except for chronic sore throat. Tonsillectomy had been done ten years previously. Three weeks before examination, the patient had developed an infection about the nail of one great toe. This infection had apparently disappeared and the boy had been well until the sudden development of acute pain in the right knee joint. A rheumatic affection had been suspected by the physician in charge who had given salicylates without effecting improvement. Pain, swelling, and temperature had increased. The patient had been nauseated and had vomited once.

At examination on September 5, 1933, the temperature was 102 degrees and the knee joint was distended so that its circumference was two inches greater than that of the opposite knee. Moderate local heat was evident. The leukocyte count was 11,000, with 84.5 per cent. polymorphonuclear leukocytes.

The roentgenograms showed increased density of the soft parts, indicating distention, particularly in the suprapatellar pouch and the posterior part of the joint in the region of the popliteal space. A diagnosis of acute purulent arthritis of the right knee joint was made.

On the day of examination, the joint was aspirated and cloudy fluid, containing fibrin, was released under marked pressure. The routine treatment of joint washing and closure was carried out. A smear of the joint fluid showed numerous pus cells and a few gram-positive diplococci, some of which were intracellular. The culture yielded a growth of streptococcus hemolyticus.

The temperature range for the first nine days following the operation was 101 degrees to 103 degrees. On the fifth day after operation, clear yellow fluid, containing a little fibrin, was aspirated. It was not definitely determined whether the streptococcus hemolyticus found in the knee came from the infected toe or from some other focus. Three months following operation, there was moderate effusion into the right knee joint,

unaccompanied by acute symptoms; this gradually disappeared. Free, painless function of the knee joint resulted. Figures 10-A and 10-B indicate the range of joint motion on April 30, 1934. On this date a very moderate increase of joint fluid was noted.

Case 8. O. C., an adult male, registered on February 6, 1928, complaining of a painful left knee.

In 1922, the knee had gradually become painful and swollen and aspiration had been done. About ten days before registration, the patient had felt tired and had developed a fever. Four days before registration, he had been forced to go to bed because of severe pain in the left knee.

Examination revealed the presence of a marked effusion in the left knee joint, with distention of the suprapatellar pouch. The tonsils showed evidence of extreme sepsis and there were signs of definite infection about two teeth. The leukocyte count before operation was 17,400.

The roentgenograms, taken on February 8, 1928, showed nothing to suggest bone changes, but gave evidence of soft-tissue thickening above the patella.

The temperature rose to 102.2 degrees before operation. On February 8, 1928, eight ounces of turbid fluid were aspirated from the left knee joint. The smears showed the presence of gram-positive cocci. Following aspiration, the patient had a restless night, and the next day the effusion returned.

On February 9, 1928, the joint was opened by an internal anterolateral incision and was washed out for thirty-five minutes with normal saline solution at 105 degrees Fahrenheit. The fluid was turbid, greenish-yellow in color, and contained much fibrin. The synovial membrane was oedematous and injected. The joint was closed in layers. Culture of the fluid from the knee produced a pure growth of staphylococcus aureus.

After the first two postoperative days, the temperature rapidly receded. On February 21, the thirteenth day after operation, the sutures were removed, there was no free effusion, and the knee was symptom-free. On the following day, the patient left the hospital using crutches.

By March 17, 1928, the patient had had two infected teeth removed with little reaction. The infection in the knee joint had quieted and physiotherapy was started. The range of motion of the knee joint was 180 degrees to 135 degrees. The patient was urged to have the infected tonsils removed, but this he failed to do.

On April 23, 1933, the patient was admitted to the University Hospital of the University of California, under the care of Dr. LeRoy C. Abbott. There had been an onset of spontaneous pain and tenderness over the medial aspect of the distal end of the left femur just proximal to the knee joint. There was an associated, acute inflammation of the pharynx and tonsils, but no known trauma.

Examination revealed tenderness over the medial aspect of the distal end of the left femur with local heat and without redness. The left knee joint contained no excess of fluid on palpation. The range of active motion in the knee joint was 130 degrees to 90 degrees. The tonsils were grossly infected. The temperature, which was 100.8 degrees when the patient was admitted, rapidly subsided and became normal.

The roentgenogram of the lower left femur showed a pyriform lesion, indicating an old, chronic, low-grade osteomyelitis. The margins of the lesion were densely sclerotic.

Treatment consisted of immobilization of the limb on a splint at 130 degrees' extension, frequent hot packs, and tonsillectomy on the third day of the patient's stay in the hospital. Practically complete range of motion returned during the week in the hospital. The patient was discharged on April 28, 1933, with the knee in a cast and flexed to 120 degrees. There was complete subsidence of pain and tenderness at the time of discharge.

COMMENTS

The combined factors of local trauma and the presence of a distant focus of infection are very prominent points in the cases reported, and

they indicate accessory treatment in the way of focal eradication in addition to the joint washing. In the records of six out of the eight patients, trauma and a distant focus seem closely related etiological factors, causing the purulent arthritis. One cannot lightly dismiss this relationship in a majority of the cases. In Case 2—that of the child who developed osteomyelitis of the tibia, associated with a septic knee joint—it is likely that the septic tooth and the trauma to the region of the knee were both factors in the development of the osteomyelitis. It is probable that the infection in the tibia extended into the knee joint, because the signs indicating trouble in the knee joint developed after those in the tibia; however, one cannot be sure that the infection of the knee joint was not hematogenous in origin. The patient in Case 1 associated the onset of trouble with a very definite wrench to the knee while playing tennis, and he presented definite foci of infection. In Case 5, the osteopath had manipulated the shoulder a few days after a septic tooth had been removed.

Several points about the pathology of septic joints have an important bearing on treatment and deserve consideration. The surprising resistance of the synovial membrane to infection is a fact long emphasized by Cotton. This resistance is well illustrated by the progress of affairs in Case 2. Here, the marked distention of the knee joint, shown in Figure 2, was discovered ten days after drainage of the adjacent tibia for osteomyelitis. As an example of the extreme resistance of the synovial membrane, it is to be noted that the second washing took place four days after the first, and not until the second washing was the very radical operation done on the osteomyelitic tibia, which probably prevented further backing up of pus from the tibia into the knee joint. This is even more than Cotton would expect from joint washing, for he has not advised it when a focus in a nearby bone communicates with the joint[7]. However, it should be stated that in Case 2 a communication between the focus in the bone and the joint was not demonstrated.

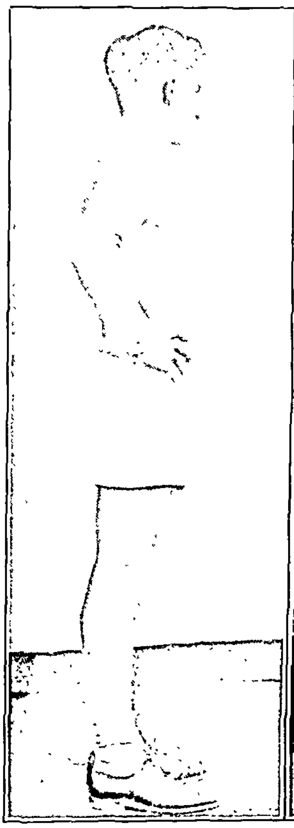

FIG. 10-A

FIG. 10-B

Case 7. Photographs taken on April 30, 1934, indicating range of active motion in the right knee joint.

The resistance of the synovial membrane to infection is probably

associated with the bactericidal properties of the synovial fluid, a point made by Girdlestone, Butler, Ellis and others[1]. In support of this bactericidal property, Ellis reported that he had seen as many streptococci as polymorphonuclear leukocytes in the fluid from a knee joint and that a culture of the fluid was sterile, indicating that the bacteria were dead. Later, when the knee joint in this case was incised, drained, and washed out, many live streptococci were found upon culture. Probably this is one explanation why positive cultures are not more regularly obtained by culture of aspirated fluid from purulent joints. Butler expressed the belief that only fresh synovial fluid possessed bactericidal properties, and Blake stated that accumulated products in a joint delayed absorption and interfered with circulation. All this would indicate that, in addition to repeated aspiration, a joint washing or thorough drainage is necessary before prolonged joint distention takes place.

Several points about the treatment should have consideration. The first has to do with the choice of an irrigating fluid. It is probably not very important whether we use 1 to 15,000 bichloride solution in saline or plain normal saline. The writer believes that normal saline is sufficient. It is likely that cleansing is effected more by mechanical than by chemical means. The warmth of the irrigating fluid must induce local arterial hyperaemia, which is an advantage in combating the infection. Another point to be decided is whether the irrigation shall be by two cannulae or by frank arthrotomy and lavage followed by suture. Reich favors the cannular method and reports a splendid series of surprisingly good results. Theoretically, it seems possible that fistulae might follow the track of the cannulae. The author prefers the method of arthrotomy and suture.

The type of case chosen for the joint-washing procedure is important. There are the fulminating cases of septicaemia that cause death in a very few days, in which a suggestion of joint localization precedes death by a few hours. Such cases are not amenable to any type of treatment. On the other hand, there are the inflammatory effusions of mild degree that recede with aspiration or repeated aspiration and neither the clinical findings nor the character of the aspirated fluid demands anything more than aspiration, local heat, or Bier's hyperaemia, together with rest in bed as suggested by Lonergan[8]. In between these two extremes of mild and fulminating cases may be classed those in the present series. It is in the intermediate type of case, neither mild nor extremely fulminating, that the joint-washing procedure seems particularly indicated. As the case reports show, certain very acute purulent joints respond to this treatment. The author's experience supports the enthusiastic contentions of Cotton, Ellis Jones, and Reich.

Treatment of acute purulent joints by incision and drainage, immobilization, and traction, as carried out by Harris, must have consideration. Of forty-nine children with fifty-one suppurative joints treated by different methods, 12 per cent. died because of fulminating infections, particularly in malnourished young infants. In the survivors, there were

thirty-seven joints treated by the method outlined in this paper; and of these fourteen obtained ankylosed joints and twenty-three obtained normally movable joints. Early drainage was not possible in many of these cases, and one cannot conclude that joint washing and closure would have procured better or worse results. With our present knowledge, the method followed by Harris is to be accepted as one of the standard forms of good treatment.

In continuing the discussion relative to the choice of procedure in the treatment of acute purulent joints, one cannot dismiss the Willems treatment without a word. Certainly the reports of Willems[2], Everidge[9], and others indicate many excellent results, particularly in the septic joints caused by wounds. Obviously, as mentioned before, there are serious contra-indications to the employment of the Willems treatment for septic joints, associated with osteomyelitis or incident to septicaemia, in a very ill patient. On the other hand, if the Willems treatment is to be used, it would seem logical to apply it in cases similar to those of Willems and Everidge,—namely, those in which infection has come from without the body by penetrating wounds.

In the face of very conflicting opinions as to the proper treatment of purulent joints, it is evident that a widespread inquiry into the results obtained from the several methods of treatment is in order, so that therapy may be better standardized.

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TREATMENT OF CHRONIC RHEUMATIC POLYARTHRITIS AND SPONDYLARTHRITIS BY PARATHYROIDECTOMY

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The progressive character of chronic rheumatic polyarthritis and spondylarthritis, the difficult and inaccurate diagnosis, and the use of irrational forms of therapy have resulted in a pessimistic view as to the results of treatment of these diseases. This pessimistic opinion is now gradually being dispelled.

During 1926–1933, the All-Ukrainian Institute of Traumatology and Orthopaedic Surgery treated 219 cases of chronic rheumatic polyarthritis and spondylarthritis, the distribution of which is shown in Table I.

TABLE I

Distribution of Cases

Affection	In-Patients *No. of Cases*	Out-Patients *No. of Cases*	Total *No. of Cases*
Chronic rheumatic polyarthritis			
Primary	24	32	56
Secondary	12	17	29
Spondylarthritis	52	82	134
Total	88	131	219

The findings obtained from a study of these cases show that under a regular system of treatment satisfactory results are secured even in neglected cases.

The average duration of illness was five years and five months. The long period of treatment may be explained by the fact that the patients came to the Institute with old and neglected deformities.

With the exception of a few cases, treatment was begun by parathyroidectomy, as proposed by Prof. Oppel in 1926.

Oppel determined the rôle of the parathyroid glands in the pathogenesis of chronic ankylosing polyarthritis and spondylarthritis on the basis that, whereas in all cases of tetany and spasmophilia, followed by hypofunction of the parathyroid glands, he had found an hypocalcaemia and an increase of electromuscular excitability, in most cases of ankylosing polyarthritis and spondylarthritis there was evidence of hypercalcaemia and decrease of the electromuscular excitability. Thus he concluded that these affections might be due to hyperfunction of the parathyroid glands.

Oppel's hypothesis is confirmed by the author's findings, as well as those of Ssamarin, Savvine and Antonov, Simon and Jung, Leriche and Jung, Maragliano, Jakobovici, and others.

At the All-Ukrainian Institute of Traumatology and Orthopaedic Surgery, parathyroidectomies have been performed in eighty-three cases *.

The glands were histologically examined and in twenty-three cases, 22.5 per cent., the histological examination did not show any evidence of the parathyroid-gland tissue. It is of interest to note that most of the cases which were not histologically confirmed were those in which parathyroidectomy was performed when the procedure was comparatively new. Lately the operative technique has been improved and cases with no evidence of gland presence are rarer.

RESULTS OF PARATHYROIDECTOMY

The results of this operation may be divided into two groups,—immediate and late. Each group may be subdivided into subjective results—the patient begins to feel better and the pain disappears or subsides—and objective results—increased joint mobility, correction of the deformities, etc.

Immediate Results

Especially noticeable is the subjective improvement in the patient which has been observed in all cases; sometimes improvement is noted the first day after operation. The examination of eighty-six in-patients revealed that only eight did not show any subjective improvement. Of these eight patients, five had spondylarthritis, two primary polyarthritis, and one secondary polyarthritis.

In some cases, attacks of pain were noted during the first few days after operation, but these disappeared after a few days. In one case, the patient did not feel any improvement for an entire year, but afterward the pain subsided and the mobility of the joints was increased.

The subjective improvement is usually manifested as follows: The patients state that they feel "unbound" and that the stiffening of the spine and the rigidity of the joints have disappeared. The pain in the back and joints disappears, as well as the feeling of pressure and the girdling and irradiating pains. Breathing becomes easier and the rigidity of the muscles disappears. Some patients note an increase in the muscle power and decrease in muscle contraction. Mobility of the joints becomes greater and easier.

The subjective improvement in the author's cases was so evident that it was at first suspected that suggestion had played an important rôle. However, the same subjective improvement has been observed in

* Thirty-three parathyroidectomies have been performed since this article was written, making a total of 116 such operations. In eighteen of the 116 cases, hemistrumectomies were performed.

little children, which excludes the suggestive factor. As has been stated, in some cases subjective improvement and a decrease in blood calcium were noted, although the histological examination did not confirm the presence of parathyroid glands in the tissues removed at operation. The question then arises as to whether the improvement depends on the diminished amount of hemorrhage during the operation or on less trauma to the thyroid gland.

Simon and Weil in 1932 reported some cases in which the improvement was due to the removal of the thyroïd gland or of fat masses. This led them to employ a simple incision of the skin without any interference with the parathyroid glands. This incision was used in three cases and the immediate results seemed to be satisfactory.

For the purpose of checking these findings, the author performed an autohemotherapy, without parathyroidectomy, but followed by administration of antithyroidin, in four cases, including both adults and children. This procedure, however, did not result in any subjective improvement.

In referring to the objective positive effects of parathyroidectomy, the increase in movement has been mentioned. This increase was manifested in cases of immobility, but not of fibrous ankylosis. The increase in joint movement—mostly in the knee, the shoulder, and the elbow joints—varied from 10 degrees to 55 degrees. In one case of primary chronic rheumatic polyarthritis and spondylarthritis, the movement in the knee joints increased by 40 degrees during the first weeks after operation. The increase of movement in the right knee joint of a patient with secondary chronic rheumatic polyarthritis was 10 degrees and rotary movement was present in the shoulder joints. In a case of rheumatic spondylarthritis in which the hip joints were affected, active movement appeared in the hip joints. The movement in the elbow joints of a patient with primary chronic rheumatic polyarthritis increased by 20 degrees.

To the objective signs belongs also the increase or restoration of respiratory excursion of the thorax.

After operation, a number of patients were able to throw their hands behind their heads, to cross their legs, and to turn from side to side. In cases of spinal deformity without ankylosis, the patients noted an increase in mobility. In some patients after operation, there were observed complete disappearance of infiltration and oedema in the feet, and restoration of movements. In one case, when the patient started to walk again, the infiltration reappeared, but the movements of the joint, which had been absent before operation, became fully restored.

An important objective effect of parathyroidectomy is the decrease in blood calcium. The author examined the blood calcium in seventy-one patients before operation and in fifty-eight patients after operation and the general tendency to blood-calcium decrease is illustrated in Table II.

TABLE II

COMPARATIVE BLOOD-CALCIUM CONTENT BEFORE AND AFTER PARATHYROIDECTOMY

Blood Calcium *No. of Milligrams per 100 c.c. Blood*	Before Operation *No. of Cases*	After Operation *No. of Cases*
7– 7.9	..	2
8– 8.9	4	7
9– 9.9	20	18
10–10.9	17	14
11–11.9	10	7
12–12.9	8	4
13–13.9	4	5
14–14.9	4	1
15–15.9	3	..
16–16.9	1	..
Total	71	58

These findings coincide with those of Oppel. His figures, however, refer exclusively to ankylosing forms; whereas the author's figures refer to all cases of chronic rheumatic polyarthritis and spondylarthritis.

In eight cases of spondylarthritis in which the presence of parathyroid tissue was histologically proved, the blood analysis, ten to fourteen days after parathyroidectomy, showed the same amount of calcium as, or an even greater amount than, before operation; yet the patients were clinically much improved.

In the eight cases of this series, the preoperative blood-calcium content varied from 8.2 milligrams per 100 cubic centimeters to 10.0 milligrams, and never exceeded the normal level. The increase in blood calcium was explained by the fact that the remaining glands were in a state of compensatory hyperfunction, especially immediately after operation.

This theory is confirmed by one case of spondylarthritis in which the blood-calcium content, examined three times in the course of fifteen months, was as follows:

Before operation	10.0 milligrams per 100 cubic centimeters
Ten days after operation	11.0 milligrams per 100 cubic centimeters
Twenty days after operation	15.0 milligrams per 100 cubic centimeters
Fifteen months after operation	10.9 milligrams per 100 cubic centimeters

Parathyroidectomy has been performed not only in cases of increased blood-calcium content, but also in cases of normal blood-calcium content where there was clinically rigidity of the joints or a tendency to ankylosis. In these cases the results of operation did not differ from those obtained in cases with increased blood-calcium content. In twelve of the twenty-two cases with good results (described later), the preoperative blood-calcium content ranged from 9.0 to 10.5 milligrams per 100 cubic centimeters. This authorizes a wider use of parathyroidectomy and permits

the recommendation of this operation as an effective and early method of treatment in cases of chronic rheumatic polyarthritis and spondylarthritis in which there is an increased blood-calcium content, as well as in those cases with a normal blood-calcium content where there is a tendency to joint rigidity.

Late Results

The late results of parathyroidectomy were investigated in forty cases. The investigation period varied from six months to four years, as follows:

Investigation Period	*No. of Cases*
6 months to 1 year	16
1 year to 2 years	11
2 years to 3 years	9
3 years to 4 years	4

Development of the process took place in three cases—two cases of spondylarthritis and one of primary chronic rheumatic polyarthritis. The development was manifested by a tendency to new deformities or to an increase of the old deformities, as well as exacerbation and spreading of the pain to new joints and new points on the spine.

There was no improvement in one case of primary chronic rheumatic polyarthritis. There was no development of the process, but the operation did not bring any objective or subjective improvement.

Satisfactory results were obtained in fourteen cases—eight cases of spondylarthritis and three each of primary and secondary chronic rheumatic polyarthritis. In these cases there was a steady subjective improvement; the pain and the feeling of rigidity disappeared, and breathing became easier.

Good results were secured in twenty-two cases—twelve cases of spondylarthritis, six cases of primary and four of secondary chronic rheumatic polyarthritis. In addition to subjective improvement, this group of patients showed an increase in joint movements of the extremities and the spine, as well as an improvement in the functional capacity.

It is of interest to note one case of primary chronic rheumatic polyarthritis in which the effects of parathyroidectomy, followed by treatment by extension, were excellent.

The patient, a peasant woman, aged thirty-three, was an invalid with contractures of the hip, both knees, elbow and wrist joints. Before operation she walked in a "squatting" position with the help of her legs and hands,—almost creeping.

Parathyroidectomy and the subsequent treatment by extension resulted in an almost complete correction of all deformities; only the flexion contracture of the right elbow joint, at an angle of 130 degrees, remained. There was full restoration of all movements of the joints. Three examinations during the succeeding two years showed the improvement to be steady and permanent.

DISCUSSION

In evaluating the effects of parathyroidectomy in the cases studied, it must be borne in mind that many of these patients were in the late

stages of chronic rheumatic polyarthritis and spondylarthritis and that they had permanent deformities. It is quite possible that had parathyroidectomy been performed at an early stage more satisfactory results would have been obtained.

It must be recognized that parathyroidectomy cannot have any effect on the already ankylosed joints; nor can it, without any subsequent orthopaedic treatment, correct permanent deformities.

Parathyroidectomy serves the following purposes:

1. To prevent development of ankylosis;
2. To do away with rigidity of joints;
3. To create the most favorable conditions for subsequent methods of correction of deformities and restoration of joint movement.

These requirements are answered by parathyroidectomy. The immediate results of this operation are in almost all cases good; the late results proved to be good in twenty-two cases out of the forty which were investigated.

Therefore, it must be admitted that parathyroidectomy is an important factor in the early treatment of chronic rheumatic polyarthritis and spondylarthritis: its accurate and early performance prevents the development of rigidity and ankylosis of joints.

It must not be forgotten, however, that this operation is only one link in the chain of means of prophylaxis and treatment of chronic rheumatic polyarthritis and spondylarthritis. In addition, it is essential to determine in each case the cause of illness and to outline a plan of treatment accordingly.

TRAUMATIC SEPARATION OF THE MEDIAL EPICONDYLE OF THE HUMERUS IN ADOLESCENCE *

BY JOHN DUNLOP, M.D., PASADENA, CALIFORNIA

Fifteen cases of separation of the medial epicondyle of the humerus have come under the author's personal observation within four years. Since so few references to this condition are found in the literature, and because there is practically nothing concerning it in the more modern text-books, it is the author's belief that many such injuries are going unrecognized.

Dr. Cotton [1] has noted the results of neglect of these injuries in his report on "Elbow Dislocation and Ulnar Nerve Injury". It is with the hope of preventing such conditions by the early recognition of this unique injury that this paper is presented.

The author's attention was first called to the true picture of this lesion by the following case:

A Mexican boy, thirteen years of age, while attending school at the Olive View Sanatorium, was injured at play. The elbow was said to have been dislocated and, in order to pull it into place, traction was applied by the teacher. The patient was then referred to the resident physician. It was found that the elbow would neither extend nor flex fully, there being an arc of free movement of only 30 degrees from the position of partial flexion. Any attempt, either actively or passively, to obtain a greater amount of movement was accompanied by pain, located at the medial side of the elbow joint, and intense muscle spasm.

An x-ray examination revealed a loose piece of bone, approximately one centimeter in diameter, in the ulnar side of the elbow joint. It was not possible, however, in this x-ray to discover the area from which this fragment of bone could have come. At every point the outlines of all the bones comprising the elbow joint were smooth. An x-ray of the opposite elbow was advised and from this x-ray it was evident that the nternal epicondyle had been pulled away, separating at the epiphyseal line which was very prominent for the age of the patient. An operative procedure to investigate the condition was advised, with the possibility of removal of the loose fragment.

An incision was made on the medial side of the elbow joint of sufficient length to expose the region of the epicondyle. As soon as the superficial fascia was entered, a long tear in the deep soft structures was exposed. This tear was explored in both directions and disclosed a most interesting situation. In the lower distal portion of the wound was seen a relaxed muscle bundle which led into the elbow joint and was held snugly in this position. The joint was forced open slightly on the medial side for investigation and the muscle mass was readily withdrawn. At the end of this mass, lodged within the joint, was found the piece of bone which had been seen in the x-ray. One surface of this piece of bone resembled a cartilaginous facet; the remaining surface was almost entirely covered with dense muscle attachments. By traction, this muscle group was identified as the flexor-pronator group of the forearm.

The rent in the soft tissues was then followed up and backward and led to the medial condyle and the epicondylar area. Here was found an exact duplicate of the cartilaginous surface seen on the loosened piece of bone recovered from the elbow joint. Its

* Read at the Annual Meeting of the American Orthopaedic Association, Rochester, Minnesota, June 8, 1934.

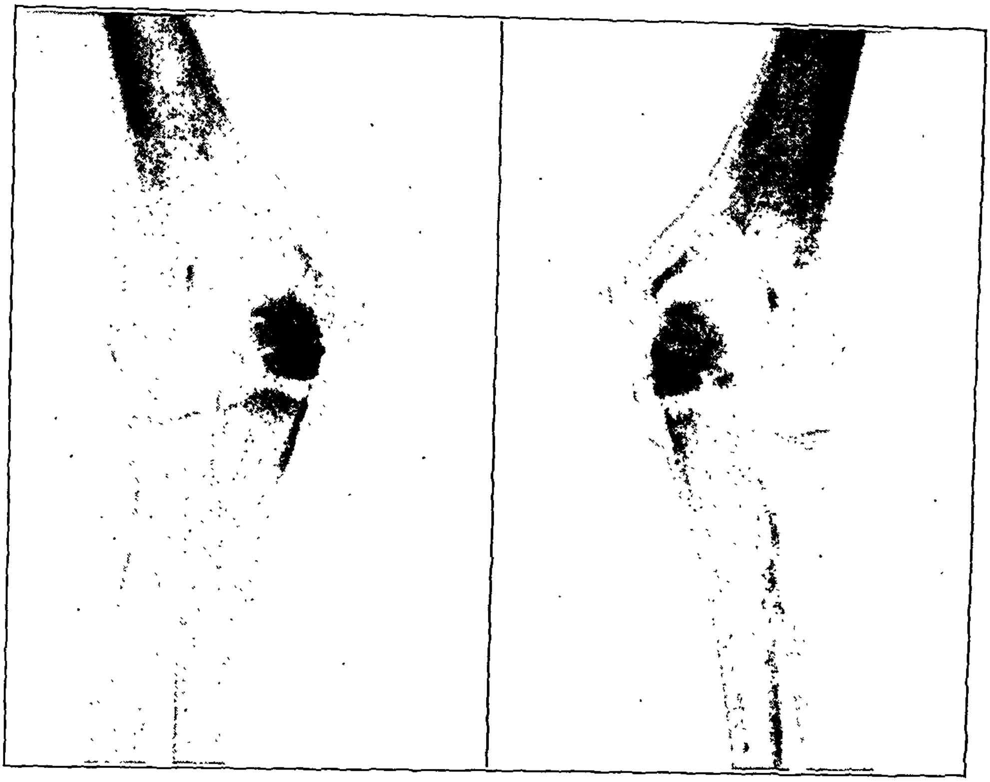

FIG. 1-A FIG. 1-B

Anteroposterior roentgenograms of both elbows of a boy eleven years of age.
Fig. 1-A: The injured elbow, showing separation of the median epicondyle.
Fig. 1-B: The normal elbow, showing normal epiphyses.

surface was glasslike in smoothness. The loosened piece of bone with its attached muscle was then drawn up into position so as to exactly fit this space on the condyle.

The ulnar nerve was located and, with the exception of its being dislocated forward and passing directly over this denuded area of the epicondylar space, it was found not to be disturbed. The nerve was retracted backward and the separated epicondyle was sutured into position. This was done with considerable difficulty as the pull of the flexor-pronator muscle group had a tendency to pull the loosened fragment of bone downward and forward.

The rent in the soft tissues, which had occurred as the fragment of bone had descended toward the elbow joint, was then repaired and the skin closed. As soon as suture of the epicondyle into position was started, it was found necessary to hold the forearm in approximately right-angle flexion throughout the remainder of the operation in order to so relieve tension of the forearm muscles as not to tip the fragment out of position. A plaster splint was then applied to prevent extension during healing.

The technique employed in all of the ensuing operations followed closely that just described; minor changes were instituted as necessity arose. The chief difficulty came in obtaining a perfect apposition of the split and separated cartilaginous surfaces.

The mechanism of the injury is still somewhat uncertain. The degree of the pathology found accounts for this uncertainty. The fact that the bone injury varies from a simple separation of the epiphysis, with little displacement, to one accompanied by dislocation and fractures of the lateral condyle and head of the radius or coronoid process of the ulna, leads the author to believe that it is produced by a force which, if con-

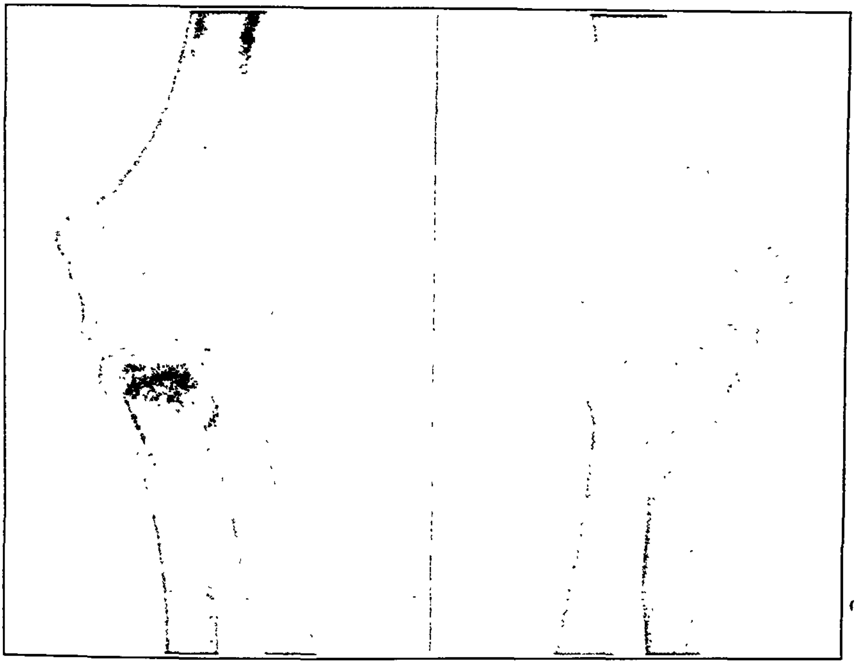

FIG. 2-A FIG. 2-B

Anteroposterior roentgenograms of both elbow joints.

Fig. 2-A: Showing the medial epicondyle lodged between the medial condyle and the coronoid process of the ulna. Note the widening of the joint space as compared with Fig. 2-B.

Fig. 2-B: Showing the normal right humerus. Note the lower contour of the lower end with the normal epicondyle in position.

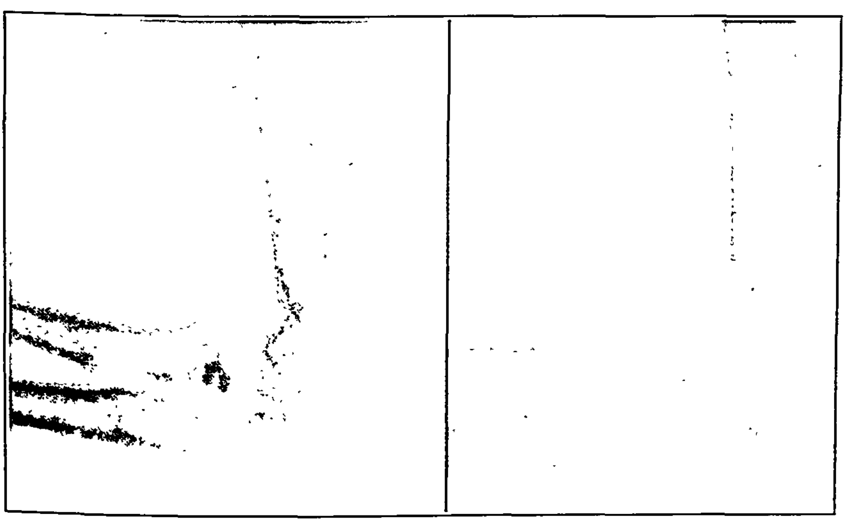

FIG. 3-A FIG. 3-B

Lateral views before and after operation.

Fig. 3-A: Before operation, showing the widened joint space and the displaced epicondyle within the joint between the condyle and the olecranon.

Fig. 3-B: After operation, showing the joint space returning to the normal.

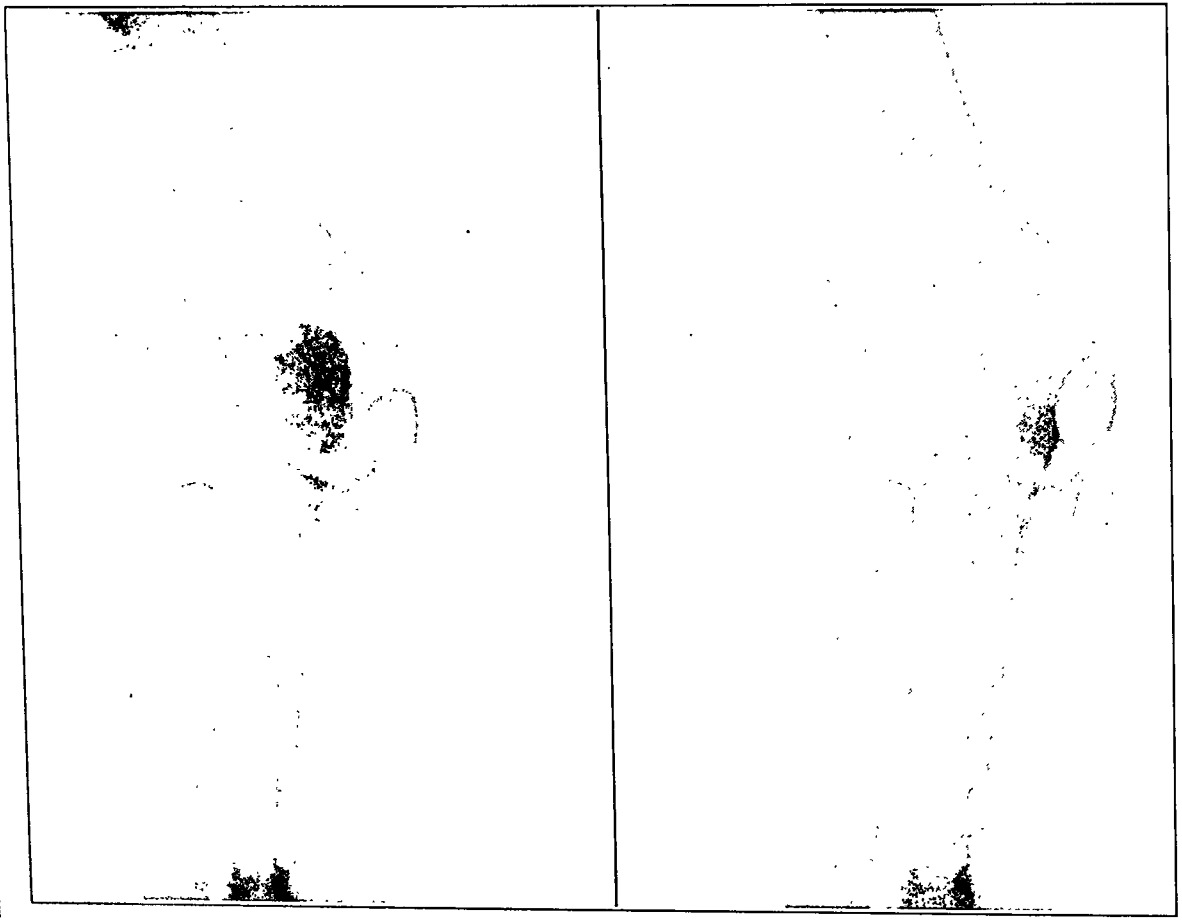

Fig. 4-A

Fig. 4-B

Anteroposterior views, showing a poor reposition. Absorbable mattress sutures were used. The shaft of the humerus was not drilled for a point of fixation.

Fig. 4-A: Eleven months after operation.

Fig. 4-B: Sixteen months after operation.

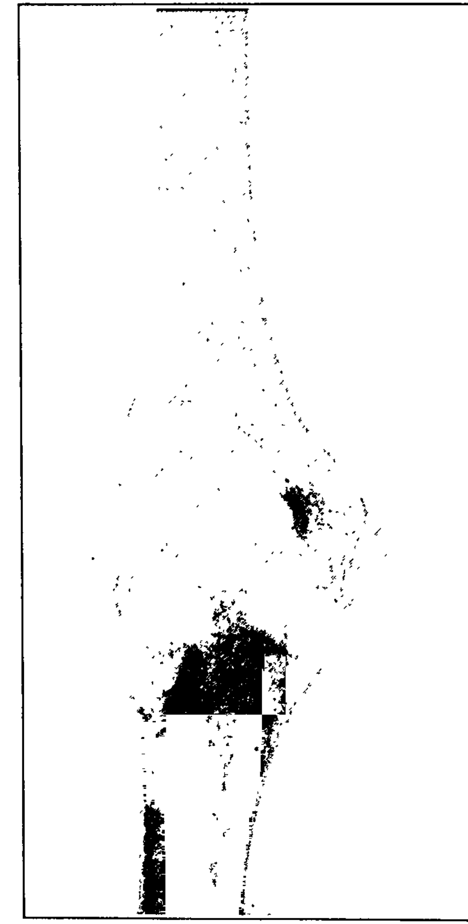

Fig. 5

In this case the shaft of the humerus was drilled and every effort was made to obtain perfect reposition; yet approximation was not perfect.

tinued, produces a lateral dislocation of the elbow joint, the degree of damage depending on the amount of force expended. For instance, such an injury might result from a sidewise fall, arrested by the outstretched hand with the arm rigid from wrist to shoulder and the hand in hyperextension. In the mild case, there is at first a giving way of the epicondyle. If the force is somewhat greater, it spreads the elbow joint on the medial side and allows the epicondyle to slip into the joint. If still further force is applied, the bone structure making up the surface of the elbow joint gives way. The severity of the injury is in direct proportion to the amount of force applied and the holding strength of the periarticular ligamentous structure. Cases will be cited to illustrate these contentions.

The mildest injury observed, as well as the only case treated without open operation, was as follows:

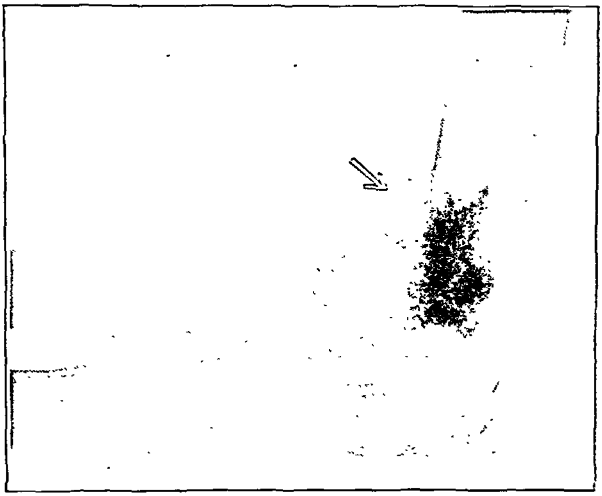

FIG. 6

The excess bone in the antecubital fossa is the remains of a considerable deposit which has gradually disappeared. This is thought to be due to the periosteal damage at the time of injury. In this case closed reduction was successfully carried out.

A boy of fifteen years, while running after another boy in play, fell forward and received an elbow injury. The author saw him within a half hour of the injury, and it was very difficult to find anything wrong. There was lack of power of forearm flexion and a loose piece of bone was felt at the medial side of the joint. An x-ray clearly demonstrated a separated epicondyle located about two centimeters below its normal position. As little tenderness could be elicited upon manipulation, an attempt to replace it was made with surprising success. The elbow was then acutely flexed and the epicondyle held in position by a piece of adhesive tape, passing down the back of the forearm, beneath and back of the loosened fragment, and anchored well up on the back of the upper arm. As this tape seemed to hold the epicondyle firmly in position, another x-ray was taken immediately and a perfect reposition was found. The case was treated in this manner to its conclusion.

The interpretation in this case was that the force used was slight and the rent in the soft tissues not sufficient to allow the separated epicondyle to fall down near the joint line.

Several other cases in this series were in a class between the case just described in which the injury was very slight and those cases where the extensive.

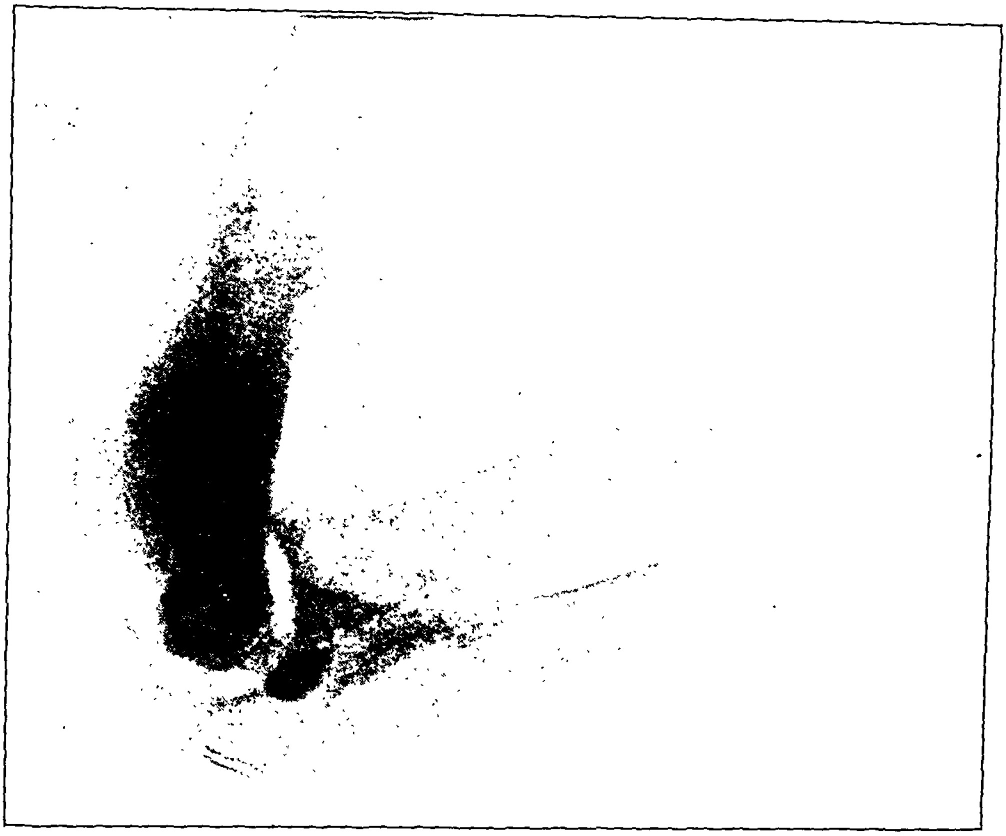

FIG. 7

Misplaced epicondyle in elbow joint where it was probably ground into the joint surface by excessive manipulation. In the region of the olecranon fossa the excessive bone deposit is due to periosteal injury. This is the case in which frequent unsuccessful manipulative attempts at reduction were made.

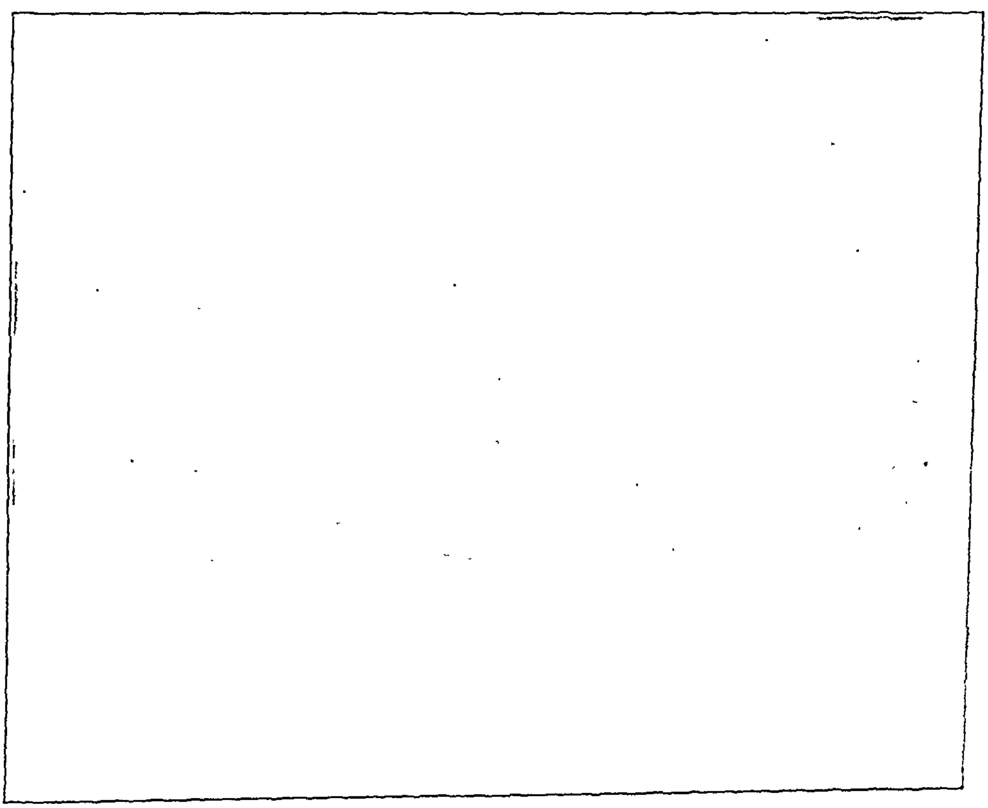

FIG. 8

A later roentgenogram of the case shown in Fig. 7, showing excessive bone overgrowth in the antecubital fossa. No further treatment was given and this is the final result.

FIG. 9-A FIG. 9-B

The only case treated by closed reduction.

Fig. 9-A: Showing a moderate degree of separation of the medial epicondyle.

Fig. 9-B: The flexed elbow shows the medial epicondyle in position six weeks after reduction. Healing is taking place.

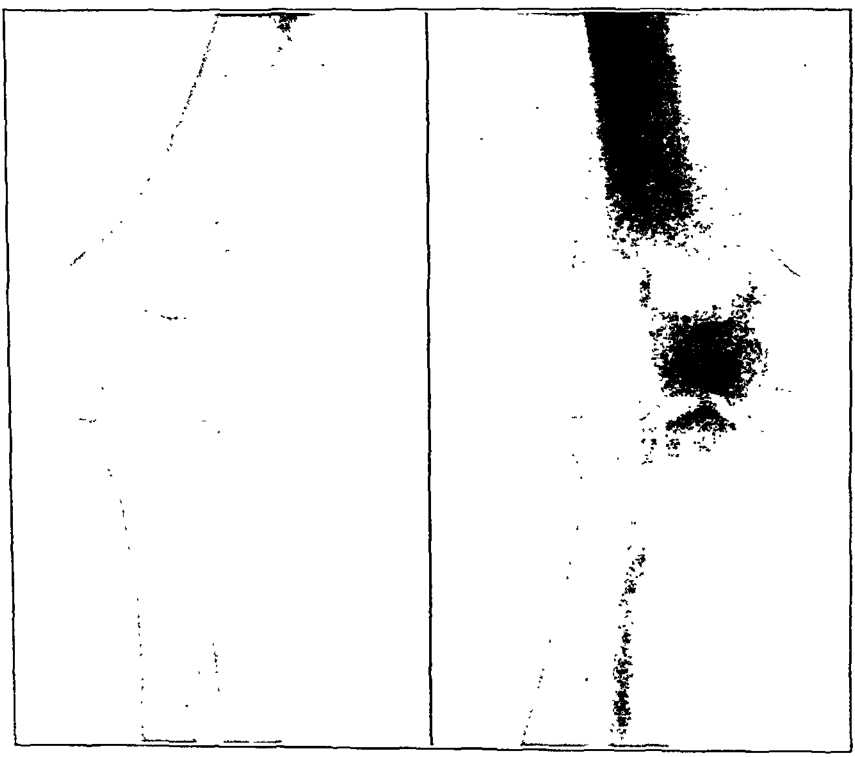

FIG. 10-A FIG. 10-B

Same case as in Fig. 9, showing two stages of repair and growth development.

Fig. 10-A: Roentgenogram taken six months after injury.

FIG. 11-A FIG. 11-B

This case represents one of the intermediate types between the simple separation of the medial epicondyle and the complete lateral dislocation. There is a moderate displacement of the separated medial epicondyle associated with an impacted fracture of the neck of the radius. In this case the force was probably not sufficient to produce a complete lateral dislocation.

At the operation for replacing the medial epicondyle, the fracture of the neck of the radius was reduced. The lateral view (Fig. 11-B), taken six months after reduction, shows an excess piece of bone at the site of the former fracture, but a well reduced fracture.

A further group included those cases where the epicondyle was definitely found to be lodged in the joint space with resultant painful joint movement. Of these cases, the most severe was that of a fracture-dislocation with an accompanying fracture of the head of the radius. In this case, the separated medial epicondyle was recognized in the x-ray only after the reduction of the fracture-dislocation. Surgical replacement was then done. In one case there was an accompanying fracture of the head of the radius with no demonstrable dislocation.

This varying pathology, therefore, seems to bear out the theory of the productive mechanism,—a pulling away of the epiphysis by muscle action, followed by a breaking open of the joint from the medial side, and, if progressive, a giving way of the bone structures to the lateral side, as seen in the injuries to the head of the radius and the accompanying dislocation.

The one unrecognized neglected case is of interest as an end result, and will partially answer Dr. Cotton's query in his report[1].

This boy had received an injury of the elbow while on the desert. He was taken to the nearest community where a diagnosis of dislocation of the elbow was made. On five successive days attempts to reduce the dislocation under anaesthesia were made without success. Several days later, the loose fragment of bone in the elbow joint was recognized and its removal advised. This was more than a year prior to the first recognized and described case. Operation was refused. The author has lately heard that this boy now has a completely stiff elbow, held in approximately the right-angle position.

No doubt the frequent manipulations in this case caused so much trauma within the joint that ankylosis resulted. This contingency should be borne in mind when difficulty is encountered in the reduction of a dislocation.

All of the patients in this small series were in the age group from nine to sixteen years. During this period the epiphyseal line is most susceptible to injury and is comparable to the traumatic separation of the tibial tubercle in adolescence. Boys predominated, no doubt due to their more rugged life. There was only one girl in the series.

From the very first, this question has been foremost in the author's consideration: "Even if the separated epicondyle is replaced, will repair take place in such a manner as to restore normal development of the lower end of the humerus?" Injury to an epiphyseal line during the growing years has always been considered detrimental to normal growth. Therefore, every effort has been made to obtain such accurate replacement that the opportunity for normal development may continue.

FIG. 12

Anteroposterior view, showing the medial epicondyle below the medial condyle of the humerus, with a partial lateral dislocation of the bones of the forearm.

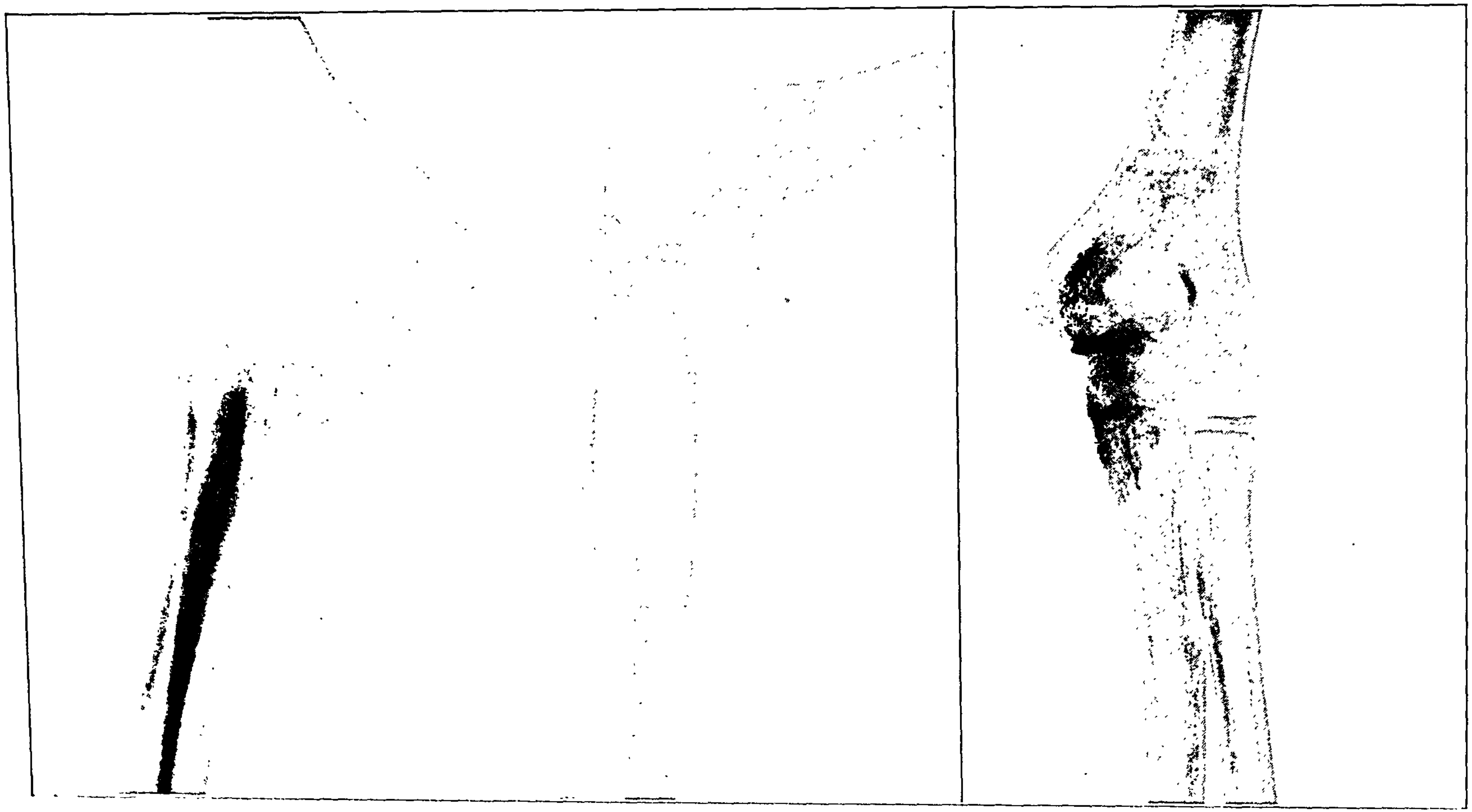

FIG. 13-A FIG. 13-B FIG. 13-C

Fig. 13-A and Fig. 13-B: Showing complete dislocation of the elbow laterally, with the medial epicondyle greatly displaced.
Fig. 13-C: Anteroposterior view of the opposite elbow, showing the epicondyle in its normal position. Compare this with the contour of the humerus in the dislocated elbow (Fig. 13-A), which illustrates the difficulty in recognizing the absence of the epicondyle when separated and dislocated.

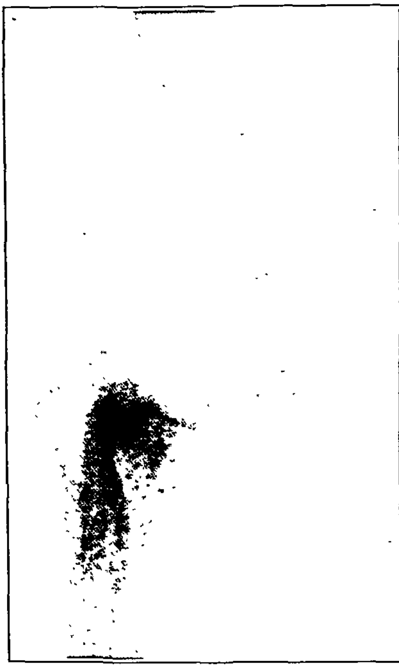

FIG. 14-A

FIG. 14-B

A second case showing complete dislocation. The lateral view, Fig. 14-C, shows the misplaced epicondyle in the antecubital space following the reduction of the dislocation.

FIG. 14-C

In the one case where closed reduction was accomplished, a normal development took place as shown in Figures 9-A and 9-B. The last films (Figs. 10-A and 10-B) were taken four and a half years after the accident and show not only a fully developed epicondylar area, but also a complete closure of the epiphyseal line. This definitely proves that healing can take place without interfering with growth.

It is true that in this case the reduction was not operative. Nevertheless, it can be effected by operation. Certainly it has been learned from successive operations that as the replacement of the epicondyle more nearly approaches an anatomical position—in other words, as experience has brought more accuracy—the more nearly is normal development obtained.

1. COTTON, F. J.: Elbow Dislocation and Ulnar Nerve Injury. J. Bone and Joint Surg., XI, 348, April 1929.

CYSTS OF THE FIBROCARTILAGES OF THE KNEE JOINT

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In 1904, Ebner [1] made the first detailed study of a case which he reported as a "ganglion of the cartilage" of the knee joint. Only ten cases were reported up to 1920, but, by 1930, forty more were recognized. Since that time there has been much discussion as to the pathological basis of the condition. Ebner considered his case to be the result of degeneration of the cartilage substance, and this view went unchallenged until 1921 when Ollerenshaw [2] put forward evidence that the cysts were congenital in origin. Since then, Jean [3] and Phemister [4] have written in support of Ebner's view. In this paper evidence will be produced in further support of the theory of degeneration and an explanation given as to why such degeneration should occur.

Ebner's case is so typical that it may with advantage be summarized here.

The patient was a man of early middle age who was struck by a heavy sack on the outer side of the knee. A few months later a swelling appeared, which was thought to be in the upper end of the tibia. This swelling was treated by external applications for many months, but, in spite of this, increased in size until it had attained the size of a pigeon's egg, when it remained stationary. The swelling was painful on extension of the knee, so that the patient could not walk, but always had to ride a horse; in this position the knee was comfortable. As no improvement occurred, the swelling was operated upon. The cyst was opened and glairy mucoid fluid evacuated. The walls of the cavity were apparently made of ragged fibrous tissue, and the cavity was found to lead into the substance of the meniscus. The cartilage was then removed entire and the wound closed. The specimen was sectioned and pronounced to be a degeneration cyst of the cartilage, with fibrous-tissue lining and endarteritis of the associated vessels.

ETIOLOGY

A study of the accounts of the fifty cases published up to 1930 brings out some interesting points. Cyst formation in the menisci is more common in men than in women, in the proportion of 72 per cent. in men to 28 per cent. in women. The patient is usually young, the average age being twenty-eight, and there is no history of arthritis or lesions in other joints or cartilages. The cysts occur in the external cartilage far more frequently than in the internal cartilage, 82 per cent. of the cysts being on the outer side and 18 per cent. on the inner side of the knee. In twenty cases out of the fifty reported, there is a definite history of *trauma*, the nature of which is more often that of a direct blow on the knee than a twist or strain. These observations are summarized in Table I.

Bristow [5] has suggested that the commoner occurrence in the external meniscus is due to the outward inclination from the vertical of the femur on the tibia, so that the external meniscus is subject to more weight-

TABLE I

STATISTICAL TABLE CONSTRUCTED FROM THE LITERATURE

Case Reported By:	No. of Cases	Sex	Average Age	Type of Trauma	Cartilage Affected
Ebner	1	Male	40	Blow	External
Ollerenshaw	21	Male: 17 Female: 4	28	Blow: 5 Twist: 3 None: 13	External: 17 Internal: 4
Bristow	11	Male: 6 Female: 5	32	Blow: 4 None: 7	External: 9 Internal: 2
Royal College of Surgeons, Museum Specimens	6	Male: 4 Female: 2	27	Blow: 2 Undefined: 1 None: 3	External: 4 Internal: 2
Jean	3	Male: 3	21	Trauma undefined: 3	External: 3
Phemister	2	Male: 1 Female: 1	20	No history	External: 2
Records of St. Bartholomew's Hospital	2	Female: 2	24	No history	External: 2
Records of the Royal National Orthopaedic Hospital	1	Male	36	No history	Internal
Hermon Taylor (cases reported in this paper)	4	Male: 3 Female: 1	33	Blow: 2 No history: 2	External: 4
Total	51	Male: 35 Female: 15	28	Blow: 14 Twists or undefined trauma: 7 No history of trauma: 30	External: 42 Internal: 9

bearing and hence more likely to degenerate than the internal meniscus. However, it seems that this cannot be the correct explanation, as the condition is far less common in women, whose femora have a greater deviation from the vertical than those of men.

The initial cause of the cysts seems to be a *contusion* of the affected meniscus. In support of this argument, several facts are to be noted. First, the external cartilage, which is the more frequently involved, is more exposed to *direct* trauma than the internal cartilage, which is subject rather to tears due to twisting strains on the knee. Second, where cysts *have* occurred in the internal cartilage, the trauma, when reported, was a direct blow on the *inner* side of the knee, not a twist or strain. Third, in the external cartilage the cysts invariably occur in the middle third, which is the only part exposed to direct blows, as the two ends recede from the edge of the tibia under cover respectively of the ligamentum patellae and external lateral ligament of the joint where they are effectively protected from injury. In contrast with this, tears of the cartilage occur in

all parts of the meniscus. Fourth, although trauma is reported in only 40 per cent. of the cases, this is a suggestively large proportion when it is considered that the injury in other cases may not have been serious enough to have been remembered by the patient, who finds a swelling over the knee some months later. Indeed, as is suggested later in this paper, the mildness of the trauma is an essential factor in the cystic degeneration of the cartilage.

The contusion is typically followed in from one to six months by a swelling on the outer side of the knee, which rapidly reaches the maxi-

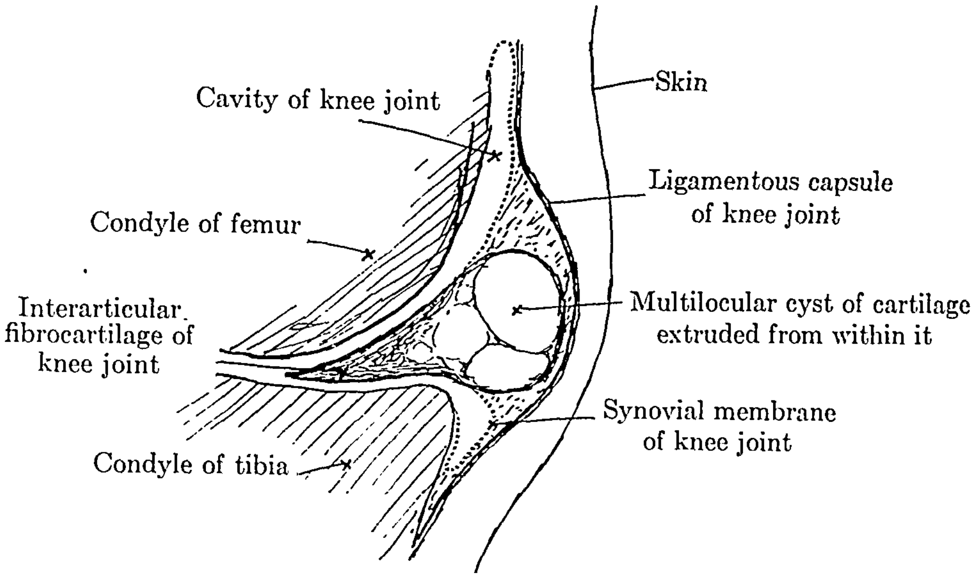

FIG. 1
Diagram showing location of the cyst.

mum size of between one and two inches in diameter, and remains without further increase in size until it is removed. The fully formed cyst is rounded, oval, tense, and elastic, lying with the longer diameter horizontal *in the joint line* immediately over the meniscus, and presents none of the signs of inflammation. The swelling becomes slightly less tense when the knee is flexed, the pressure on the cartilage being thus relaxed. It is but slightly painful on pressure, and usually gives the patient pain only on extreme flexion or extension of the joint, or after much use of the limb. The commonest complaint is that the lump gives rise to a dull ache in the knee and interferes with its movements.

PATHOLOGY

The cysts lie on the superficial surface of the meniscus, but extend deeply into its substance, so that the cross section of the cyst is roughly pear-shaped, as though it had been extruded by pressure from the cartilage (Fig. 1). The cysts have no connection with the synovial membrane or the popliteus tendon, of which they have been thought to be ganglia, or with the bursa under the external lateral ligament of the knee joint, from which again they were supposed to have arisen.

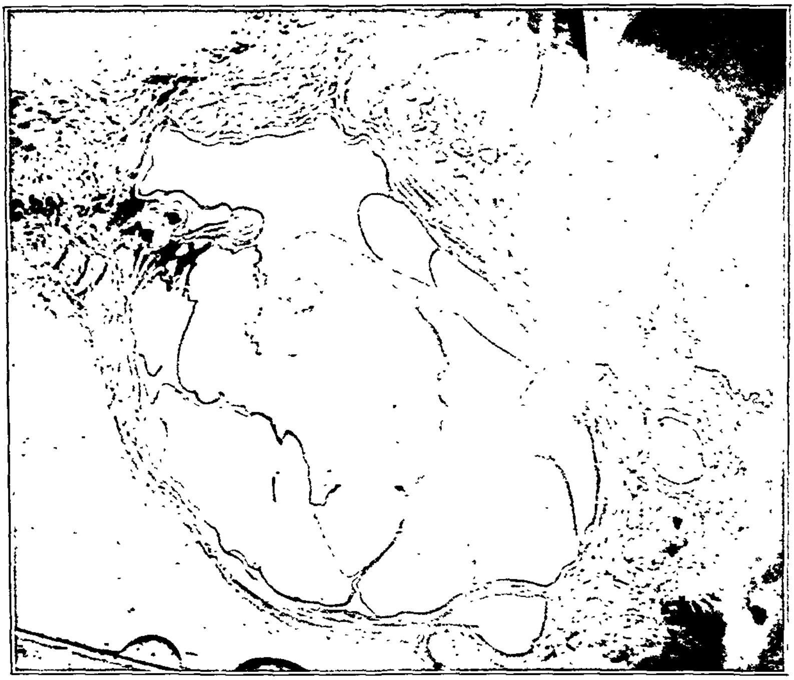

FIG. 2

Low-power photomicrograph, showing the complete cyst, lying on the subcutaneous surface of the cartilage, with its loculi distended with fluid, and the septa between them. Outlying small cysts can be seen in the substance of the cartilage at the base of the main cyst.

FIG. 3

High-power photomicrograph of part of the cyst wall. On the left side, the lining cells have every appearance of endothelium, but, on tracing the layer around the cyst wall, it can be seen to break up into spindle cells which lie along the fibrous wall of the cyst.

The cyst is tense and the wall fibrous, and on incision a clear yellow gelatinous substance exudes from it. Careful examination of the cut surface with the lens shows the cyst to be multilocular with fine septa separating the loculi from each other. The cartilage underneath looks dull yellow and is more friable than normal, but near the articular surfaces it approaches the normal appearance, being more translucent and of a faint bluish color, while the upper and lower articular surfaces are unaffected.

It has been mentioned that there is a difference of opinion as to the pathology of the condition. Most observers consider it to be mucoid degeneration of the white fibrocartilage of the meniscus, but Ollerenshaw maintains that the cysts are derived from embryonic rests of synovial cells within the cartilage, which are stimulated by the trauma to secrete fluid and form distention cysts. In support of his view, Ollerenshaw points out that the synovial membrane and menisci develop from the same foetal tissue, the "interchondral disc" between the femur and tibia, which differentiates into the meniscus and the synovial membrane during development of the knee joint. But the basis of his theory is that he has observed what he describes as an endothelial lining to the cysts, which he considers similar to the lining of the synovial membrane of the joint. However, it can be demonstrated that this lining is not endothelium, but a compressed and stretched layer of proliferating fibroblasts around the cystic spaces. The development of this layer of fibroblasts is discussed in detail; Figure 3 clearly illustrates the structure.

The other sections illustrated in this paper demonstrate the successive stages of degeneration that occur in the cartilage and lead to cyst formation.

In the first stage (Fig. 5), the fibrils of the cartilage are swollen and indistinct and take the stain poorly, while the cartilage cells are beginning to disintegrate. In places the fibrils have disappeared and become a clear homogeneous substance, and the beginnings of small cysts can be made out. Coincidently there is *chronic inflammatory reaction* in the more normal tissue around the degenerate area, whereby the central area becomes surrounded by a zone of round-cell and spindle-cell proliferation. These cells can be seen in the periphery of the field in Figure 5.

As the area of degeneration enlarges into a cyst, the surrounding zone of young fibrous-tissue cells is compressed and stretched, so that the spindle-shaped cells lie parallel to the cyst wall; and, as the tension within the cyst further increases, these cells form a flattened layer along the cyst wall, so that in section they may have the appearance of a layer of endothelium (Figs. 3 and 5).

It seems fairly clear that these cysts are the result of a degenerative process in the cartilage, but the reason for the degeneration is more difficult to seek. It has been suggested that it is due to a primary endarterial thickening caused by the trauma that so often precedes the occurrence of the cyst. In a few places in the sections, thickened arteries can be seen near the cysts, but this is not a constant finding, and, as the patients are

FIG. 4
Low-power photomicrograph, showing all stages of the process from the early hyaline change in the middle of the cartilage to the formation of the cystic spaces on the surface. This specimen collapsed during removal.

mostly young people in sound health, there seems no likelihood of primary vascular disease. Further, there are no arteries within the cartilage substance, so that primary vascular obliteration due to trauma would be more likely to cause degeneration, if at all, in the tissues around about, rather than in, the cartilage itself. This, however, is not the case, for the tissues around the menisci are healthy and bleed normally at operation, indicating an adequate blood supply.

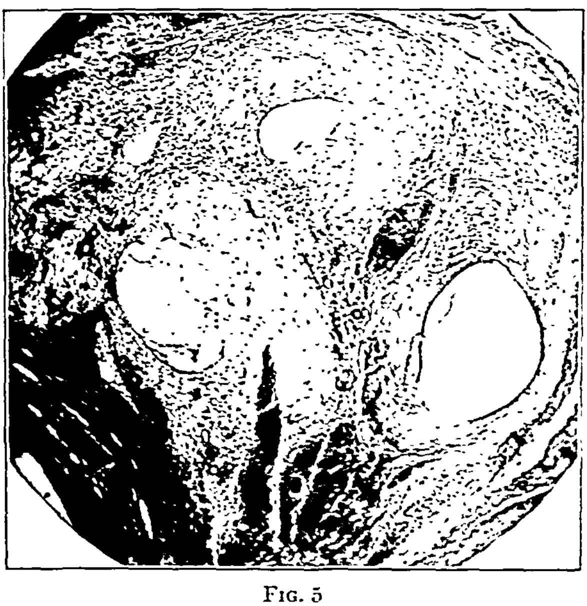

FIG. 5
High-power photomicrograph, showing the first stage of the degenerative process.

The following suggestion is put forward to explain the occurrence of degeneration in the carti-

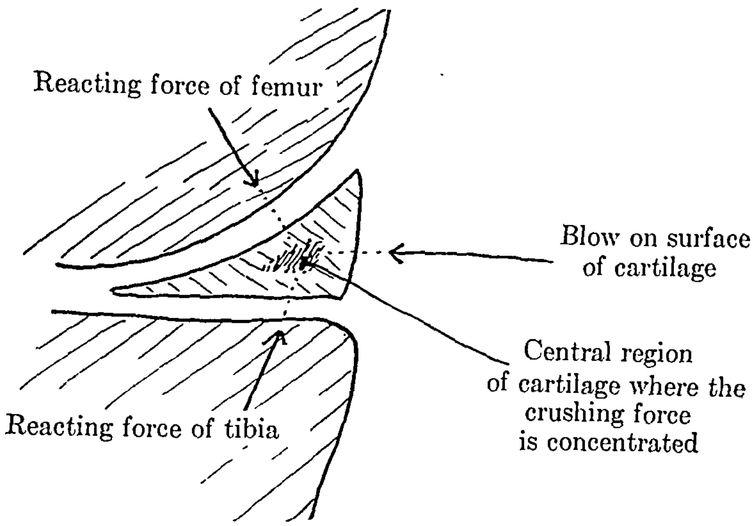

Fig. 6

Diagram showing mechanism of the injury.

lage. First, as demonstrated earlier in this paper, there is a blow on the cartilage which, being wedge-shaped in cross section, is driven in between the condyles of the femur and tibia. The resultant of the force of the blow, together with the reacting pressures of the bones, is concentrated in the central region of the cartilage, as illustrated in Figure 6. This contusion of the central tissue of the cartilage is followed by exudation of fluid, but, as the relatively undamaged cartilage is so firm around this zone, it allows no swelling to take place. Hence the exudation of fluid causes increased tissue pressure and degeneration of the cartilage substance with the formation of viscous fluid similar to that in ganglia. This fluid further increases the pressure and the degeneration continues, with the formation of a cyst which enlarges and expands toward the surface. When, however, the cyst has become large enough to extrude itself from the cartilage, the tension within it falls, the sequence of events is broken, and the remaining cartilage does not degenerate further, so that the cyst does not further increase in size.

This hypothesis agrees with the clinical findings that the cysts increase rapidly in size up to from one to two inches in diameter, when they remain stationary. Also it postulates as the origin of the degenerative process direct trauma of the mild type which is met with in these cases, for degeneration is dependent on the increased tissue pressure developed in a bruised but intact cartilage, whereas in a ruptured or torn cartilage the fluid exudation would escape without pressure and the cartilage would not degenerate, but heal.

TREATMENT

Operative measures are usually indicated, as the patient is generally otherwise healthy and the presence of the cyst considerably impairs the usefulness of the limb.

The pathological process described in the preceding pages lays stress on the deep-seated degeneration in the cartilage underlying the cyst. Hence superficial operations for removing or curetting the cysts are useless. This procedure has been followed in several cases—in two by

Ollerenshaw, in three by Schmidt[6] and in two by Riedel[7]—and in each case a recurrence has followed, necessitating further operation. The rational treatment is to remove the entire cartilage.

The operation differs only slightly from that for tears of the cartilage. The capsule of the joint is pushed outward by the cyst, but forms a separate layer over it which is incised to expose both the joint and the cyst and is resutured after removal of the cartilage. Consequently, there is no more subsequent disability of the joint than after the ordinary operation of meniscectomy. In the cases reported, function of the joint has afterwards been normal and in no case has there been a recurrence of the swelling.

CASE REPORTS

Case 1. F. B., a male, thirty-nine years old, was first seen in October 1930.

Sixteen months previously the patient had fallen off a bicycle and sustained a blow on the knee, causing a bruise. For five weeks prior to examination he had had pain in the knee on walking, and a tense cystic swelling had developed rapidly over the external cartilage.

At operation, the external cartilage with cyst entire was removed by Mr. Meyrick Thomas and examined histologically (Fig. 2). The patient had an uneventful convalescence and was discharged walking in three weeks.

Case 2. C. J. K., a male, aged nineteen, was seen in September 1933.

The patient had been kicked on the outer side of the knee during a game of football seven months previously. Beyond momentary pain, no symptoms had occurred until five months later, when pain on the outer side of the knee drew the patient's attention to the swelling there.

On examination there were full movements of the joint, but pain on full extension. A tense, elastic, cystic swelling, measuring two inches by one inch, was present in the joint line over the external cartilage with the long axis horizontal.

At operation the cartilage was removed by Mr. S. L. Higgs. Recovery was uneventful and subsequent function perfect.

Case 3. I. C., a female, aged thirty-four, was examined in September 1930.

The patient had noticed a swelling on the outer side of the knee for a long time. She could not remember any trauma to the knee, but the knee had given way once three years previously and again a fortnight prior to examination, with great pain and subsequent increase of the swelling. The knee was painful on walking, especially up and down stairs.

On examination there was disclosed a small, tense, oval swelling over the middle of the external cartilage.

The external cartilage with cyst was removed by Mr. R. C. Elmslie. The patient was discharged walking in a fortnight.

Case 4. C. B., a male, aged thirty-nine, was seen in March 1930.

The patient gave no history of trauma. He had had pain and swelling on the outer side of the knee for two years; this had been the worst in the morning.

On examination a cystic swelling in the joint line over the external cartilage was present.

The external cartilage with cyst was removed by Mr. J. E. H. Roberts and microscopically examined. The section showed typical multilocular cystic degeneration of the cartilage.

The patient was discharged walking in three weeks.

CONCLUSIONS

1. *Etiology:* The cysts are consequent on direct trauma, usually on the outer side of the knee, causing a contusion of the meniscus.

2. *Pathology:* The cysts are multilocular and are due to progressive mucoid degeneration of the cartilage substance, from the center of which they have been extruded. They are lined with a layer of compressed young fibrous tissue, the end result of the round-cell proliferation around the areas of degeneration.

3. *Treatment:* Removal of the entire cartilage. Lesser procedures are followed by recurrence.

The author is indebted to Mr. Harold Wilson, Mr. R. C. Elmslie, Mr. J. E. H. Roberts, and Mr. S. L. Higgs of St. Bartholomew's Hospital for permission to publish these notes of their cases, and to Mr. Meyrick Thomas for his valuable help with the histological work.

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FEMORAL SHORTENING FOR EQUALIZATION OF LEG LENGTH *

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The purpose of this paper is to call attention to the advantages of a solution of the problem of discrepancy in leg length, which, in the writer's estimation, has not received the emphasis it deserves, particularly during the last seven or eight years since Abbott's [1] beautifully conceived technique for lengthening the short leg appeared. This idea, the execution of which was made so practical by Abbott, has far greater appeal to the imagination of both surgeon and patient than the more prosaic alternative of shortening the long leg, and, in spite of the greater difficulties of achievement, has enjoyed by far the greater popularity. The wave of enthusiasm throughout the country that followed the publishing of the lengthening procedure has receded to a certain extent as the end results in many poorly selected cases have been observed. Therefore, the writer feels that a report of his conclusions after shortening forty-five long legs during the last seven years is justified at this time.

The idea of shortening the long leg must have occurred to the ancients, but Steindler [18] gives credit to Rizzoli for having first recorded it in 1847. In a thorough search of the literature, relatively few articles have been noted. In 1917 the senior Shands [17] reported three cases, and subsequently five other references in English, [2, 3, 15, 16, 19] four in German, [6, 7, 9, 13] and more recently two in French, [4, 12] and one in Italian, [5] were found. In none of these articles was any considerable series reported except in one German publication[7] where approximately eighty cases were cited, in which the operation had been performed by various operators. No technique, however, was mentioned in this paper. In no article has the procedure to be described been employed. Where any definite method was mentioned in the various articles, it was considered to be so complicated as to be impracticable.

Patients who have enough discrepancy in the length of their lower extremities to necessitate the consideration of an equalization procedure usually have some other disability which has played an important rôle in the production of the disproportion, and which in itself, even if adequate equalization is obtained, still constitutes a handicap. A procedure that would increase the stability of such a disabled individual unquestionably deserves consideration. It is common knowledge that, all other factors being equal, the stability of an object varies inversely with the height of the center of gravity and, therefore, any plan that has for one of its objects the lowering of this center of gravity is worthy of serious contemplation.

* Presented at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Chicago, Illinois, January 10, 1934.

Almost invariably the long leg is the sounder and is more amenable to corrective measures for length than the leg that has suffered some insult which has resulted in its being short. In lengthening the short leg, particularly in cases of residual poliomyelitis, both the involved atrophic muscles are further weakened by stretching and their leverage action is made more inadequate by lengthening the long arm of the lever of the third class.

A very important criticism of the idea emphasized in this paper is that the well leg is jeopardized. This fact, of course, cannot be denied and due consideration should be given it in coming to a final decision. After everything has been done to correct existing deformities, the decision as to the procedure to be followed should depend upon the attendant circumstances in each case. The ability and confidence of the operator, as well as the conditions under which the actual operation is performed, must be carefully considered. If the fear of surgical sepsis causes apprehension on the part of the operator, shortening of the long leg should not be attempted. In four cases in the author's series a rise in temperature, ranging to a fraction over 102 degrees, developed several days after the operation, followed by a seropurulent discharge from the pin wounds for a few days. These pin wounds have been interpreted as surgical sepsis even though they cleared up spontaneously, usually in a few days, a fortnight at the longest. More serious trouble developed in another case and two ring sequestra had to be removed at a subsequent operation before final healing took place. No further trouble has occurred in any of these five cases, but in two of them it has been less than a year since the operation was done. For a while, an Albee electric motor was employed in inserting the pins and it was felt that the high speed tended to scorch the tissues about the drill holes and cause necrosis. The writer believes that this is true and advises either the use of the hand drill, although it is much more laborious, or very careful use of the motor, stopping frequently in order to avoid overheating, and constantly irrigating with normal saline solution.

There is a definite aesthetic reaction against reducing height. No one can deny that the shortening tends to be humiliating both to the morale and to the physical constitution of the individual. The author is using the word "humiliating" in its true etymological sense, remembering that it is a derivative from the Latin which means "to make nearer the ground". Some people are more sensitive about this than others, and, in spite of the mechanical advantage obtained and regardless of the disability that a short leg entails, they would never consider physical debasement. In such cases, if surgery is to be considered, the leg-lengthening procedure is to be preferred.

In the author's series, the youngest child operated upon was eight years of age, while the oldest adult was forty-two. Practically all the cases were in children under fourteen. The average amount of shortening or overlapping was two and one-half inches. In one patient whose height was sixty-five inches, overriding of three and one-eighth inches was ob-

tained without ill effects. In no case was the leg shortened less than two inches. The minimum discrepancy which the writer considered necessary for a shortening operation was two inches, regardless of the height. In a few instances, in which the shortening was due to trophic disturbances following anterior poliomyelitis and it was felt that as the child grew the discrepancy in growth would continue, an overcorrection was done, amounting to half an inch in some cases. In these cases the writer wishes that he had been even more radical. For the past five years, all leg lengths have been figured from the x-rays for the sake of greater accuracy, and the amount of distortion as shown on the film has been carefully calibrated.

In several of the most recent younger cases, particularly in the cases of poliomyelitis, premature ossification of the epiphyses according to Phemister's [14] technique preceded the shortening operation.

The present technique has been gradually evolved and has not been changed for the last two years. It has been employed in less than half the cases, seventeen to be exact. The simplification of the procedure without jeopardizing the final result has been continually sought.

TECHNIQUE

In brief, the technique finally used in the last seventeen cases of this series consists of a simple transverse osteotomy of the mid-shaft of the femur in which the periosteum is meticulously separated to a distance of about an inch beyond the desired amount of shortening of each fragment; the fragments are then allowed to override the correct amount and are maintained in close parallel approximation by obliquely placed removable pins until consolidation occurs. Four years ago, the resection of a segment of the femoral shaft was discarded as being an unnecessary and time-consuming detail of the operation and the principle of overriding which, according to Brooke[2], was originally advocated by Sayre in 1863, was adopted. In addition to simplifying the operation, it is felt that the increase in bony contact of the overriding fragments is a tremendous stimulus to early consolidation, and, under ordinary conditions, makes the wearing of a brace unnecessary. At the time when Sayre advocated femoral shortening by the overlapping of the bone ends, he was, of course, in no position to use any method of internal fixation, and the writer has delayed about making any formal report until a fully tested and practical technique for adequately holding the overriding bone fragments had been devised. The excess amount of bone in the thigh at the overriding does not constitute an objectionable feature, for in a few years, at least in the case of a growing child, normal architecture reestablishes itself and the site of the operation is barely seen in the x-ray. (See Figure 1.)

A Lanman clamp serves to hold the overlapping bones in proper position while the pins are being placed. As the compressed bulk of shortened muscles tends to elongate the thigh, the two pins (bicycle spokes) are placed parallel and obliquely about an inch apart, so that the expansive tendency will force the parallel fragments together, as shown

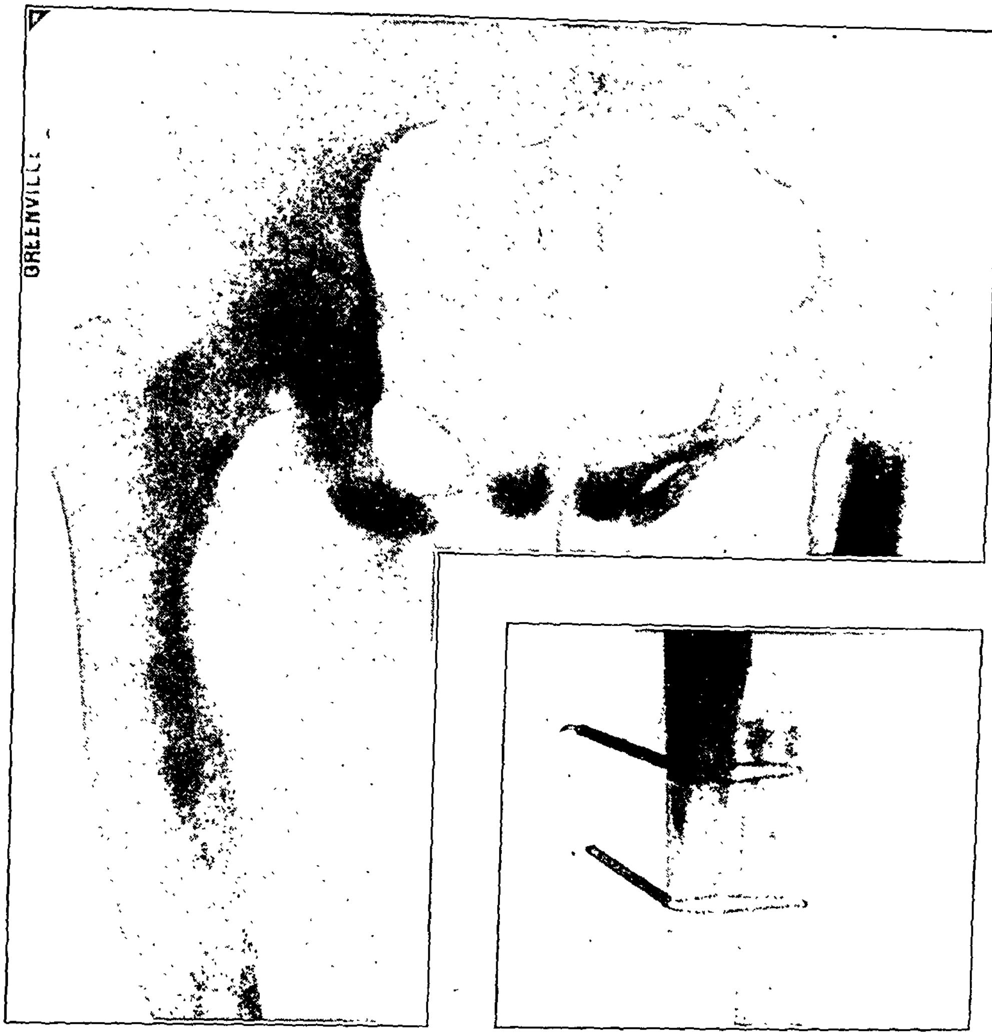

FIG. 1-A FIG. 1-B

Case 25. A girl, thirteen years of age. This is one of the earlier cases in which overlapping was maintained by removable wire bands instead of pins.
Fig. 1-B: Seventeen days after operation.
Fig. 1-A: Fifteen months after operation, showing rapid reestablishment of normal architecture.

in Figure 2. The pins are allowed to project possibly a quarter of an inch beyond the bone on the further side and to come out through the wound, which is closed in layers in the usual manner. In arranging the overlapping bones, care must be taken that they lie in the same plane as the wound so that the parallel pins can project out of the wound without straining the suture line. This sometimes takes a little careful manoeuvering and is quite important.

A plaster hip spica is applied from the toes to above the costal border with the hip slightly flexed and abducted, the knee somewhat flexed, and the foot at a right angle. The pins are incorporated in the cast and, after they are cut off so as to allow about an inch to project, they are bent at right angles flush with the surface of the cast. A few turns of plaster covers them. This place is marked so that at the end of four weeks the

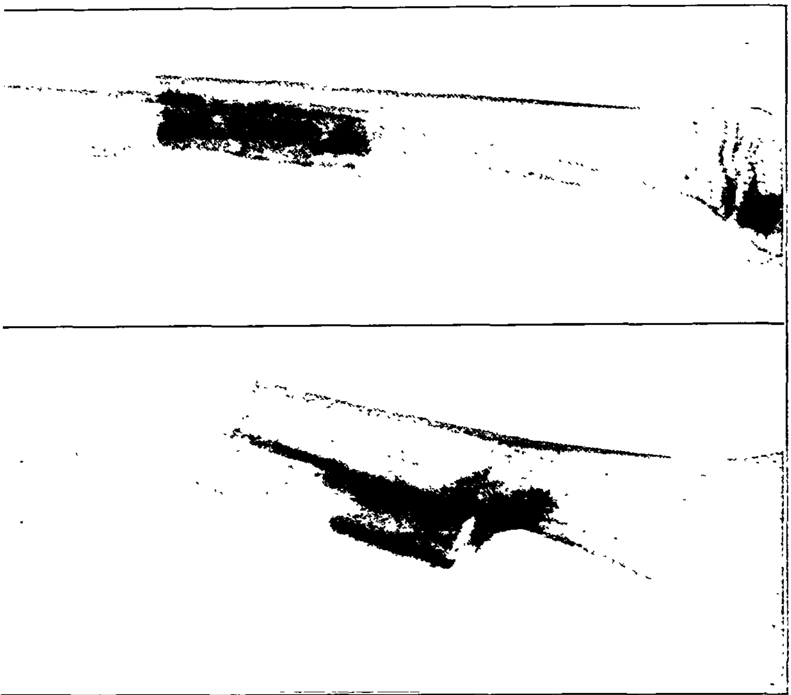

Fig. 3

Same case as in Fig. 2 on removal of cast eight weeks after operation; the pins had been drawn out through the cast four weeks previously. Note adequate callus.

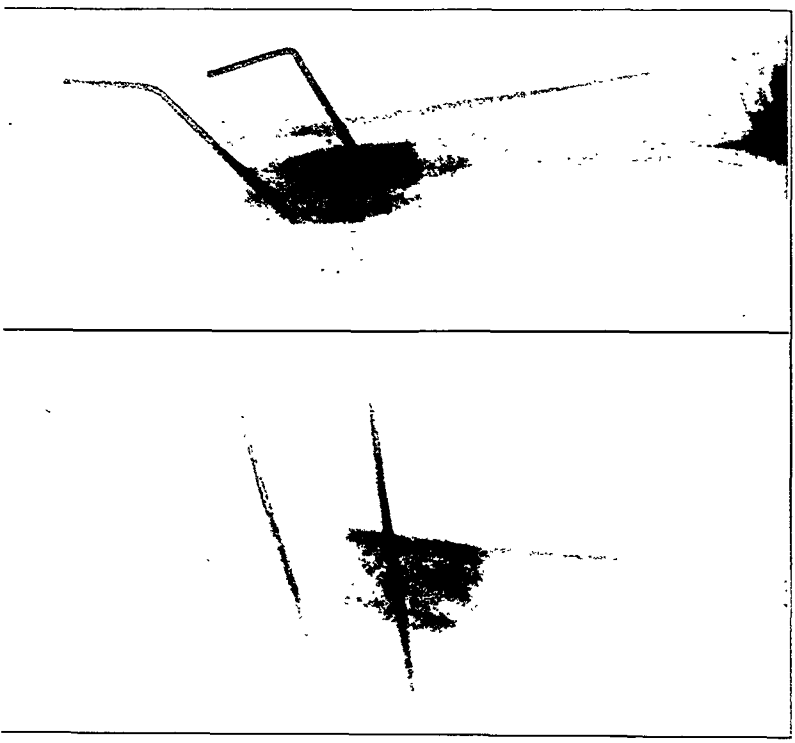

Fig. 2

Lateral and anteroposterior roentgenograms, taken immediately after operation, showing overlapping. Note obliquity of pins.

bent-down ends can be easily found and the pins pulled out. The cast is removed at the end of another four weeks and, if the x-ray shows good callus (as in Figure 3), physiotherapy is started and weight-bearing when advisable. If consolidation is apparently delayed, further protection by either a cast or a brace is applied for as long a period as necessary.

Space is lacking for a review of the development of the present method, but the author believes that it is necessary to explain why the excision of a section of the shaft to effect the *shortening* has been discarded. Such a procedure necessitates another osteotomy and enhances the difficulty of maintaining satisfactory apposition. After the segment has been removed, the bulkiness of the shortened muscles tends to keep the bone ends apart (Fig. 4) and a very secure method of internal fixation is necessary. The making of a medullary peg from the excised segment and the insertion of cross dowels to hold the bones together are time-consuming and there is too great risk of fracturing the peg during the completion of the closure, the application of the cast, and even afterward. The leaving of a projecting peg on one of the fragments for insertion into the medullary cavity of the other has been found to be even more time-consuming and such a peg is more prone to subsequent fracture. Overlapping-step operations were discarded as being too complicated.

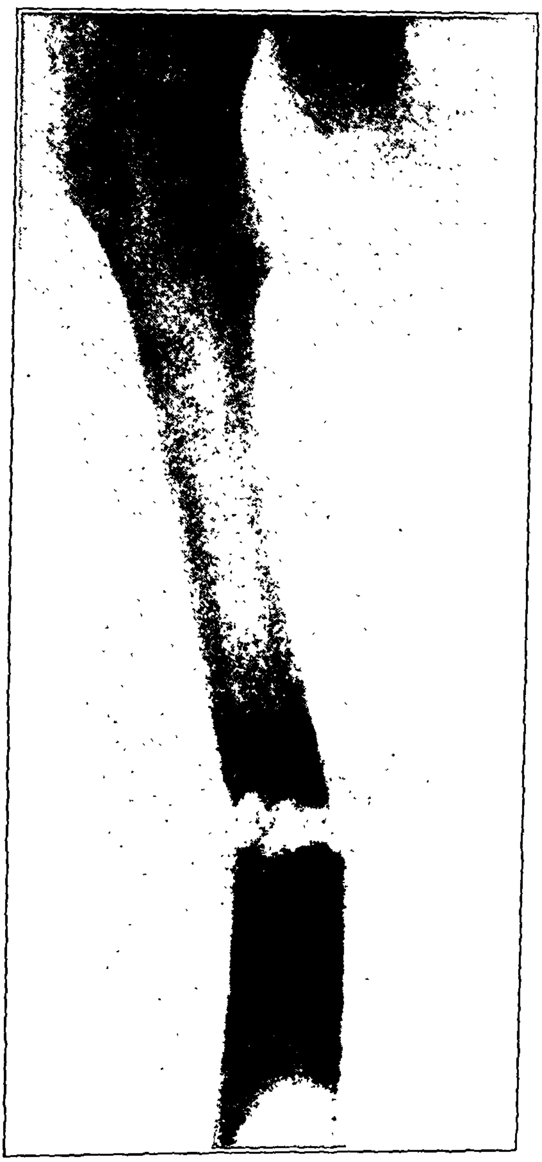

FIG. 4

Case 2. Roentgenogram, taken immediately after operation, showing separation of bone fragments as a result of the expansive force of the compressed thigh muscles after the peg had broken off from the proximal fragment which had been inserted into the medullary cavity of the distal fragment.

The employment of non-absorbable material which cannot be removed easily has been studiously avoided. It has been found that the constant strain placed on an absorbable suture, such as heavy catgut, kangaroo tendon, or fascia lata itself, is too great and the suture often gives way. Absolute immobilization of the bone ends cannot be obtained by any external type of fixation and the unavoidable slight movement

of the patient tends to wear away gradually but surely the retentive sutures, even if extreme care is directed to the rounding off of the suture holes through the bone. In addition to the major movements necessary in the early postoperative care of the patient, there is at the site of the operation some movement associated with the patient's very breathing.

It is hoped that this résumé of the difficulties involved in removing a section of bone will explain the reason for resorting to overriding of the fragments with the consequent ease of internal fixation.

END RESULTS

In this series of cases, it has been found to be the rule rather than the exception that the quadriceps femoris, relatively lengthened by the shortening of the thigh, has regained sufficient tone to permit its holding the lower leg fully extended at the knee against gravity when the cast is removed at the end of the eighth week. Varying amounts of relaxation of the knee have occurred, but no permanent disability has been noted; nor has there persisted any permanent weakening of the thigh muscles. Each case in this series has been carefully followed up and there is no evidence that any leg so shortened has suffered any impairment in strength or usefulness.

In conclusion, the writer is of the opinion that shortening the long leg, according to the technique described, is a relatively simple and safe procedure and can well be added to the surgeon's armamentarium.

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INTERNAL DERANGEMENT OF THE KNEE JOINT *†

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In dealing with this subject, it is the author's purpose: (1) to consider certain anatomical points in connection with the knee joint; (2) to discuss the mechanism of injury to the semilunar cartilages, based upon the operative findings in a large series of cases; (3) to consider certain points in the differential diagnosis of injuries of the knee, especially the rotation strains; (4) to describe the technique of operation, the after-treatment, the complications, and the results.

ANATOMY AND PHYSIOLOGY

No general description of the anatomy of the knee joint is called for, but it is necessary to bear in mind the important rôle which is played by the muscles, especially the quadriceps extensor.

The knee is a complicated joint, ill-adapted to withstand rotation strains. In fact, there is no mechanism other than the quadriceps which prevents rotation until the knee is locked in full extension.

The muscles are the first line of defence against strain, and it is only when the first line breaks down that strain on the ligaments comes into play. This doctrine is fundamental to an understanding of the results of trauma as exemplified in injuries of the knee. It has been said that because a patient is admitted to a surgical ward it does not necessarily mean that he needs an operation; as a corollary, it should be emphasized that because a patient has strained his knee it does not necessarily follow that the cartilage requires removal.

Quadriceps insufficiency is not infrequently the cause of recurrent sprain of the knee joint, for, if the first line of defence gives way, strain is applied to the ligaments and, with great strain or too prolonged strain, the ligaments are ruptured or stretched, giving rise to a weak and painful knee.

The internal lateral ligament has received undue prominence in the literature of the surgery of the knee joint. This ligament is made up of a superficial layer of fascia—a continuation over the joint of the deep fascia which covers the leg and thigh—and is separated from the deep layer by a loose, fatty, and areolar tissue. This band is attached above to the inner aspect of the inner femoral condyle and blends with the capsule and finally with the periosteum of the antero-internal surface of the tibia. From its deep surface, fibers pass obliquely downward to be attached behind the center of the superior border of the internal semilunar cartilage. This attachment does tend to anchor the posterior part of the internal semilunar cartilage. The site of attachment of the deep part of the ligament

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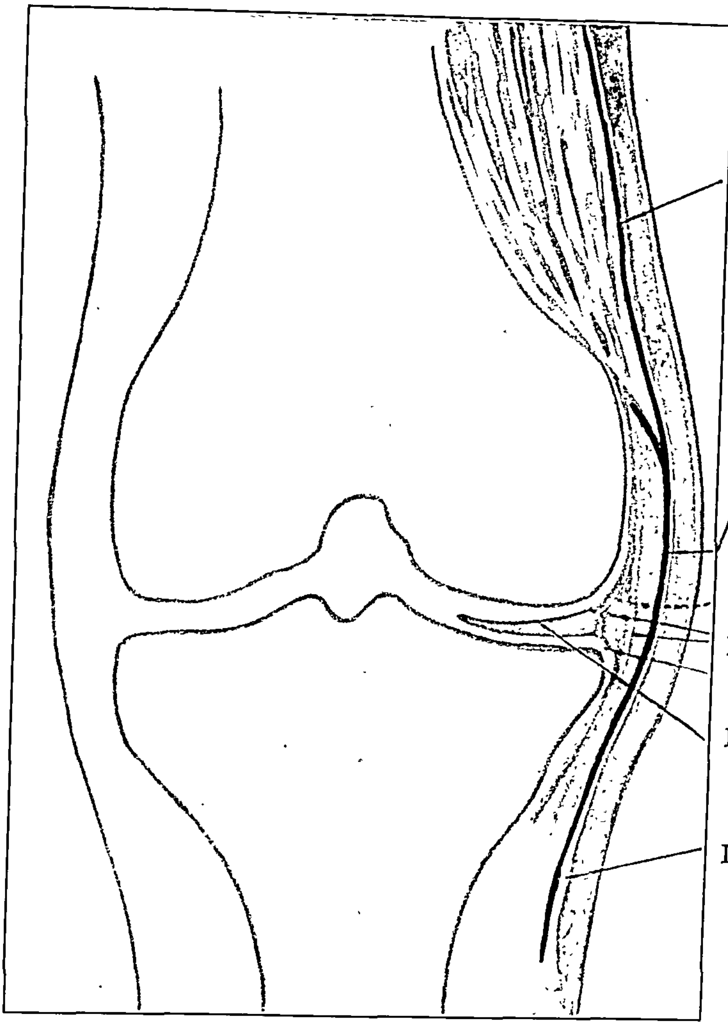


FIG. 1

Drawing taken from section of knee joint, showing arrangement of deep fascia and internal lateral ligament.

to the femur should be noted, for it is here that the ligament ruptures. In a patient with an abduction strain of the knee, the site of tenderness can be predicted with certainty,—one inch above the joint line and very definitely localized to this small area.

The coronary ligaments which attach the periphery of the semilunar cartilages to the tuberosities of the tibia are thin, weak structures. The ligament attaching the internal semilunar cartilage is the shorter, six millimeters in length, and allows less excursion of the inner cartilage than the longer external coronary ligament, ten millimeters in length, allows of the outer. These coronary ligaments may be torn with rotation strains, but with appropriate treatment repair should follow. The anatomy of the attachment of the coronary ligaments is worthy of attention, for it is following rotation strains that adhesions are likely to arise and give trouble. The sequence of events would be: tear of ligament, with hemorrhage; organization of clot; and formation of fibrous tissue. The normal excursion of the cartilage is thereby limited in rotation, giving rise to

pain when the adhesion is put on the stretch,—that is, in full movement with rotation of the joint. Modified rest, together with physical treatment should cure a sprain,—that is, should allow repair of the ligament to take place.

The semilunar cartilages are avascular except at the periphery, and for this reason when there is a split in the substance of the cartilage repair cannot be expected. It has been shown experimentally that an incision into the substance of the cartilage near the free edge shows no tendency to join, and clinical experience goes to prove the same thing. There is no evidence, either macroscopically or by examining sections of a torn cartilage, that any repair is taking place and at operation the author has never seen a pannus growing forward from the periphery in an attempt at repair. If this is true, it must modify the accepted treatment of the primary lesion. To expect a torn cartilage to be repaired after a few weeks' rest in plaster, or on a back splint, is unwarranted. Such treatment will allow repair of a tear of the coronary attachment, but not of a split in the substance of the cartilage.

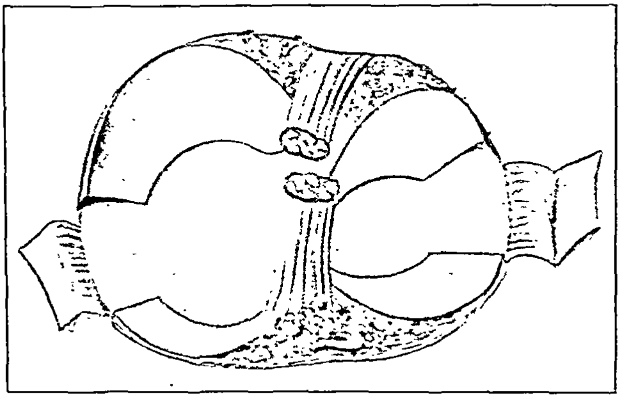


FIG. 2
Diagram of coronary ligaments.

The semilunar cartilages are not covered by synovial membrane, as it used to be thought; indeed, synovial membrane does not cover the parts of joints exposed to pressure.

The semilunar cartilages appear to have a twofold function: they tend by their shape to adapt the tibial tuberosity to fit the femoral condyle and compensate for the alterations in shape of the articular surfaces between flexion and extension; but more important is their function in the lubrication of the joint surfaces. It has been suggested by MacConaill that their function is to produce and maintain a convergent wedge-shaped film of synovia between the bones, and so minimize friction.

At the commencement of movement there is less friction if the gliding surfaces are not parallel to one another, but inclined at an angle. The semilunar cartilages insure this wedgelike action by virtue of their shape and provide for two films of synovia.

If the knee is opened after the cartilages have been removed, their place is taken to some extent by fibrous tissue, which sometimes conforms in shape very nearly to the periphery of the removed cartilage,—an

attempt by nature to make up the loss. In practice, it is the common experience that the removal of these cartilages does not handicap the majority of patients.

The only other structure to which reference will be made is the so called fat pad,—that large mass, intracapsular but extrasynovial, which fills in the gap between the condyles under the patella and its ligament.

The anatomical points relating to the posterior approach and to the patellar branch of the saphenous nerve will be considered more conveniently in discussing details of operation.

MECHANISM

There is no general agreement on the mechanism of cartilage injury, and there is no uniformity in the published description of what the surgeon sees or *thinks he sees when he explores a knee joint which reveals a torn* semilunar cartilage.

There are three main types of injury to the knee, which are distinct as regards mechanism and which are seldom combined:

1. *Lateral strain:* commonly caused by abduction of the knee, resulting in a simple strain of the internal lateral ligament or rupture of the femoral attachment of that ligament; more rarely caused by adduction of the knee, resulting in strain or tearing of the external lateral ligament.
2. *Rotation strain,* which may result in a splitting of the cartilage if weight is being borne on the limb, or in damage to the coronary or other attachment, if there is no direct transmission of weight through the joint.
3. *Hyperextension strain,* resulting in a tear of the anterior crucial ligament or an avulsion fracture of the tibial spine.

As the result of a very severe crush fracture, such as we saw when a man was blown up or buried by high explosives in the War, a combination of crucial-ligament tear and cartilage injury or of a ruptured lateral ligament and a torn cartilage was sometimes seen, but in the writer's experience either combination is exceptional in civil practice.

In 1924, at a meeting devoted to a discussion of this subject, those who reported their operative findings revealed a striking diversity of opinion as to the mechanism of the injury. The discrepancy in the operative findings tends to make the question still more obscure. An analysis of the findings in a small series of seventy-seven operations reads as follows:–

Anterior end of cartilage detached	32
Detachment of cartilage from posterior half of coronary ligament,—*i.e.*, circumferential tear	9
Tag projecting into joint, usually from about the middle of the cartilage	8
Cartilage displaced into intercondylar notch (bucket-handle)	8
Cartilages normal	8
Cartilages normal, but hypertrophied fat pad	5
Various obscure types	7
Total	77

No real connection between these various forms of fracture or displacement could be seen at the time of the discussion. However, after rereading these findings and examining the drawings made of them at the time, it is the author's belief that they all fit in with the following conception of the lesion:

The primary injury to the cartilage is a longitudinal tear or split in the substance of the cartilage, caused by the direct compression or grinding action of the femur on the tibia, with an added trauma caused by a rotation force, when the weight is borne on the leg with the knee flexed.

A consideration of the history of a primary injury resulting in a torn semilunar cartilage will usually be found to contain these three factors,—the flexed knee, rotation, and weight-bearing. This triad is not necessary for a second or subsequent displacement for, as is well known, the cartilage may become displaced while the patient is lying in bed.

Now, if the primary injury is a longitudinal split in the substance of the cartilage, how can one explain the displacements met with on opening the joint?

Figures 3-A, 3-B, and 3-C illustrate the sequence of events according to the author's conception.

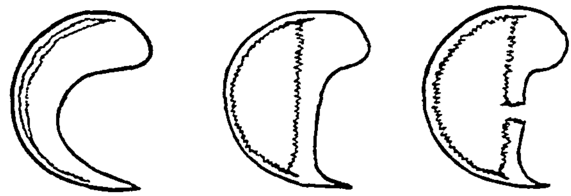


FIG. 3-A FIG. 3-B FIG. 3-C

Diagram of complete longitudinal tear in three stages.

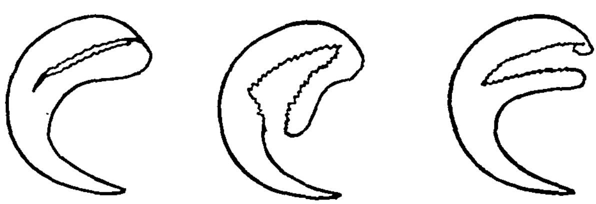


FIG. 4-A FIG. 4-B FIG. 4-C

Diagram of posterior tear, showing three types of split.

FIG. 5-A FIG. 5-B FIG. 5-C

Diagram of anterior tear, showing three types of split.

A longitudinal tear may be complete or confined to the front or back of the cartilage. In the case of the complete tear, the central portion may lie undisplaced in proximity to the peripheral portion, as is sometimes seen; it may be displaced across the joint, coming to lie between the condyles,—the so called "bucket-handle"; or it may be ruptured in the middle. Thus, there are three types with the complete tear.

In the case of the tear which is confined to the posterior part of the cartilage, there may be no displacement or either the front or back end

may be torn off with displacement of the central fragment toward the middle of the joint. This displaced part is usually described as a transverse split, but is, in reality, a primary longitudinal tear, with an end ruptured. The same is true of the tear which is confined to the anterior part of the cartilage.

The illustrations show the tags or tonguelike processes in a purely diagrammatic way in order to make the mechanism clearer. At operation they often appear as small rounded blobs, and it is sometimes hard to determine the exact site of their origin.

This simple explanation would seem to bring into line the various and seemingly different accounts of what is seen when the joint is opened.

There is nothing new in the suggestion that the fracturing force is compression, but the hypothesis is strengthened by the clinical fact that a torn cartilage is rare in children and uncommon in adolescents. The type of injury is the same in children and in adults. Schoolboys playing football are exposed to the same rotation strains and they injure themselves as frequently, yet at operation one is struck by the fact that the cartilage is generally normal. There are exceptions and occasionally a torn cartilage is seen in a schoolboy, but, with increasing experience, one makes the diagnosis less readily, and is more inclined to temporize and treat the injury as a sprain of the knee. The greater elasticity of the cartilage at this age allows it to withstand compression without actually fracturing.

The relative frequency of the injury to the internal semilunar cartilage as opposed to that of the external semilunar cartilage is explained by this conception of the mechanism of injury.

The external cartilage is more likely to escape the grinding force of the femur for two reasons. In the first place, it is less fixed and the coronary ligament allows freer excursion of the cartilage, both because of its greater length and because of the gap which occurs posteriorly in connection with the tendon of the popliteus. The second factor which saves the external cartilage is its shape. It is a circular ring, accommodating the external condyle of the femur, and it is better adapted for rotation than is the less circular internal cartilage. There is less likelihood of damage to the external cartilage because it does not have to accommodate itself to the so called gliding movement which the internal femoral condyle makes in full extension, for it is the pivot around which this movement takes place.

One of the usual explanations of the relative frequency of the injury to the internal semilunar cartilage as compared with the external semilunar cartilage is that the former is anchored to the internal lateral ligament, the injury of this structure allows the cartilage to come adrift, and its displacement ensues from a severance of this attachment.

Two clinical facts, however, invalidate this hypothesis. First, *strain* or tear of the internal lateral ligament is a definite clinical entity with a definite syndrome and is uncomplicated by an injury to the *semilunar*

cartilage. Second, a displaced cartilage is always a torn cartilage. The line of cleavage is through the cartilage itself, and a varying amount—it may be only a thin rim of cartilage—is left attached to the coronary ligament at the periphery of the tibial tuberosity.

A consideration of the operative findings (Table I) shows that in this series the relative frequency of injury to the internal semilunar cartilage over the external semilunar cartilage is nearly five to one—a lower figure than is generally given, but substantially the same as that found in all cases at St. Thomas's during the period 1926 to 1930,—namely, six to one.

Of the seventy-two cases composing the groups listed as "Normal and hypermobile" (which it is the author's belief are the same) and "Indefinite, old tears, scarring", about 10 per cent. represent errors in diagnosis.

As shown in Table II, the posterior tears formed 31 per cent. of the 629 longitudinal tears of cartilage found at operation. This figure is significant, for this lesion may easily be missed unless the surgeon is on the lookout for it and recognizes that it is common.

TABLE I

ANALYSIS OF 725 OPERATIONS FOR INTERNAL DERANGEMENT OF THE KNEE JOINT

Findings	Internal Cartilage *Cases*	External Cartilage *Cases*
Longitudinal tears	526	103
Cysts	2	18
Congenital complete disc	0	2
Loose posterior end after removal of anterior two-thirds	2	0
Indefinite, old tears, scarring	17	3
Fibrosis of fat pad, complication anterior tear *	21*	1*
Normal and hypermobile	43	9
Total	590	135

* Not included in total.

TABLE II

ANALYSIS OF 629 LONGITUDINAL TEARS OR FRACTURES OF CARTILAGE FOUND AT OPERATION

Type of Tear	Internal	External	Total	Per Cent.
Complete	277	23	300	48
Posterior	143	52	195	31
Anterior	106	28	134	21
Total	526	103	629	100

DIFFERENTIAL DIAGNOSIS

The history is of paramount importance. An accurate and detailed history is well worth the expenditure of time and trouble which it necessitates.

Recurrent Displacement

There is little difficulty in arriving at a correct diagnosis of recurrent displacement when a patient states that his knee was injured at football a year or two previously and since that time has given way on some four or five definite occasions; that he fell because the knee gave way and not because he was tackled; that the knee would not straighten and that he was assisted off the field limping, with the toe but not his heel on the ground; that someone pulled his leg straight, he felt something move, and was then able to straighten and bend the leg; and that the leg swelled the same evening. From such a history, the diagnosis of recurrent displacement of a torn cartilage is simple. In practice, it is only necessary to exclude a loose body.

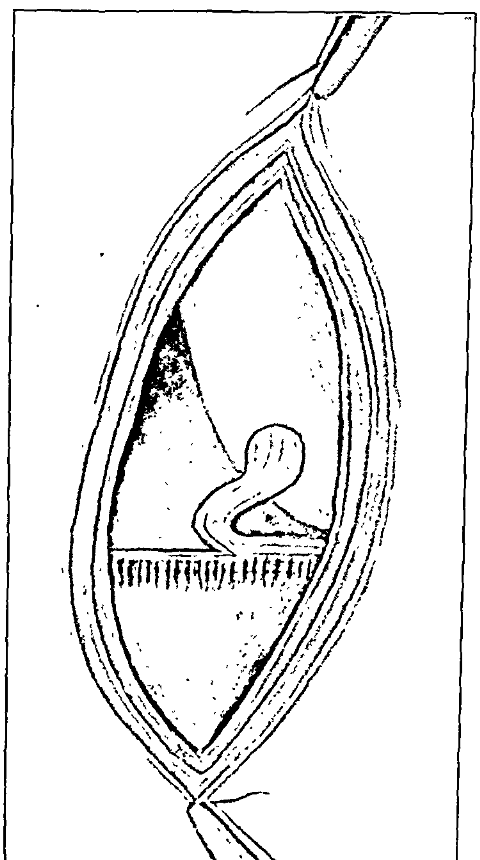


FIG. 6

Torn anterior end of cartilage, simulating a loose body.

Loose Body

A loose body cannot be distinguished with certainty unless it is felt by the patient or the surgeon, or is visible in the roentgenogram, although a consideration of the history may suggest this condition.

The points which favor the diagnosis of a loose body are briefly: (1) true locking, lasting only for a moment, with easy reduction on any movement of the knee; (2) pain on locking referred to different parts of the joint on various occasions.

Locking without accident is not to be regarded as more evidence of a loose body than of torn cartilage, because with the latter one sometimes gets a history of derangement when the patient is lying in bed and merely turns or twists the knee.

On two occasions, the author has felt what he took to be a loose body, but which on removal proved to be a torn internal semilunar cartilage displaced toward the periphery. This must be a rare occurrence. Both cases were the results of injuries at football.

Loose bodies may exist for years, giving rise to no trouble until by some twist they move and interfere with the joint mechanism.

One patient was playing hockey with her children and experienced a sudden internal derangement of the knee. She played games regularly,—tennis and the like—and her knee had not incapacitated her previously, although she had experienced what she described as "occasional nips", which had been explained by that popular diagnosis "rheumatism". Thirty-one loose bodies, resulting from synovial chondromatosis, were removed from her knee (Fig. 7).

One other example of loose body—that of osteochondritis dissecans, the so called König knee—will be of interest.

The patient, a boy of fifteen and one-half years, was brought to the author with rather vague knee symptoms. His knee did not actually let him down, but had given rise to symptoms which had brought him into the hands of one of the better known bone-setters who had forcibly manipulated the knee on two occasions. There was some fluid and muscle wasting, extension was limited and painful if forced. The symptoms were in the left knee only, although as shown in Figure 8, his was a case of bilateral König knee, the only bilateral example seen by the writer. The joint was explored. The fragment of articular cartilage and underlying bone was not detached or bulging. There was a yellowish and clearly marked line of demarcation around the body, as shown in the x-ray, but the body was not loose. Although a portion of the circumference was cut cleanly around with a thin knife, the underlying bone could not be rocked; consequently, the joint was closed. When seen three months after operation, the knee appeared normal, except for the muscle wasting. Eighteen months later, the loose body which had formed and which had given rise to the classical symptoms was removed.

Primary Injury

The diagnosis of the primary injury is a much more difficult problem than that of the recurrent lesion. The type of accident has already been referred to in discussing the mechanism,—*i.e.*, a rotation strain of the flexed knee, with weight on that leg.

Typically, the knee is said to lock, by which is meant it will not fully extend. More characteristic is the history of unlocking. If, as the result of trauma, a knee suddenly fails to straighten, is manipulated, and has its movement as suddenly restored, it must mean that the block to extension is me-

Fig. 7
Multiple loose bodies in synovial chondromatosis.

chanical—a displaced part of the cartilage or a loose body. Locking, with unlocking, is a frequent but not an invariable sign of cartilage lesion. Tenderness on pressure over the joint line is constant in a primary injury. It may not be found with recurrent displacement. The site of tenderness is of value in differentiating a cartilage lesion from an injured internal lateral ligament and is helpful in determining which cartilage is at fault. There is fluid in the joint, but seldom a hemarthrosis; the latter is found more often with a severe rotation sprain. The x-ray is negative, but should always be taken before opening a knee joint, so as to exclude bony loose bodies and avulsion fractures of the tibial spine.

In a small proportion of patients, we find the syndrome of internal derangement and diagnose and remove a torn cartilage, but can obtain no definite history of injury. It has been suggested that there is some degeneration, or other change, and that trauma is not essential as the causative factor. It seems more likely, however, that the original injury was trifling and has been forgotten, but that it was the primary cause of a longitudinal split, generally posterior, in the substance of the cartilage, produced by rotation and a grinding of the femur on the tibia, but with no displacement. The tear, once started and incapable of being repaired, enlarges with use of the knee, perhaps without further injury or at any rate with injury of the most trivial kind. When such a tear has become sufficiently long, a slight rotation force can easily dislocate part of the

Fig. 8

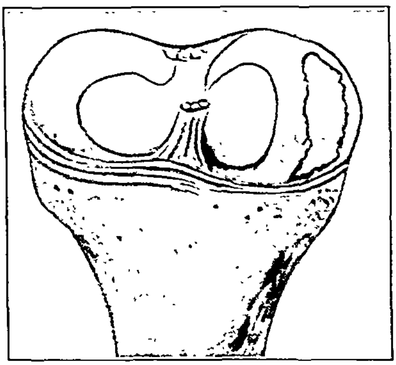
Exfoliation of cartilage in the so called König knee.

cartilage toward the center of the joint, and we have all the signs and symptoms of a primary injury and yet no accident or cause which is seemingly sufficient.

Severe Sprain of the Knee

The differential diagnosis of cartilage injury from a severe sprain of the knee is a real practical difficulty.

Lateral sprain occurs by direct abduction more commonly than by adduction; in other words, if the effects of the injury are shown by a strain or a tear of a lateral ligament, it is usually the internal ligament which



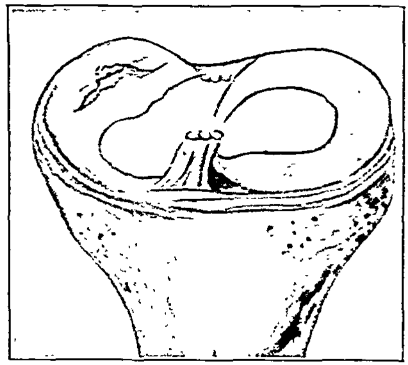


FIG. 9-A FIG. 9-B

Two stages in the tear and displacement of the internal cartilage.

suffers. Localized tenderness on pressure over the femoral attachment of the ligament, pain on forced abduction of the joint, and often *limitation of extension by spasm* are found. These tears of the ligament are generally partial. The author has repaired or replaced by operation a torn internal lateral ligament on two occasions only.

In addition to the sprains affecting and chiefly confined to one or the other of the lateral ligaments, we sometimes see a more severe and generalized sprain of the joint, a rotation sprain. The knee injured by a fall when skiing is a good example of the severe sprain which may easily be mistaken for an internal derangement. The author has opened several such knees under the impression that he was dealing with a torn cartilage.

A severe rotation strain without weight on the leg is liable to damage the attachments of the cartilages toward the front of the joint and about the fat pad,—it produces an intra-articular lesion. There is pain, fluid in the joint, and movement is limited by spasm. The range is small. The knee will neither fully flex nor extend, but has perhaps some 30 or 40 degrees of movement through an intermediate arc. The joint line is tender on palpation, and there may be oedema localized over the inner lateral ligament which may be tender too.

Now if one opens such a knee, the operative findings will vary according to the interval of time which has elapsed since the accident. In the early stages, the fluid is generally a mixture of blood and synovia. The

anterior part of the cartilage appears thickened. There is thickening about the attachments of the anterior horn and maybe a swollen fat pad. In the later stages, there is thickening and fibrosis. The author has not found a torn cartilage or a true displacement in such a case.

Under anaesthesia, knees of this type straighten and bend. The protective spasm is overcome, but, if a few weeks have elapsed since the accident, there is a feeling of spring, as if the full 180 degrees' extension were not quite maintained. Any forced manipulation makes the condition worse and operation is useless. The great factor in recovery is *time*, together with early rest and physical treatment. If the rest is complete—*e.g.*, in a plaster cast—the inflammation will subside more quickly, but adhesions will form. These are knees which repay forced manipulation later on and do not require operation for removal of cartilage. The effusion and hemorrhage into the loose cellular tissue and the fibrosis—in fact all the processes of repair—tend to cause limited movement. When these adhesions are put on the stretch, the patient at once experiences a feeling of weakness, pain, and insecurity. Early mobilization ends in disaster. The knees get stiffer and the spasm returns. Many patients are incapacitated for months, but they gradually improve with time.

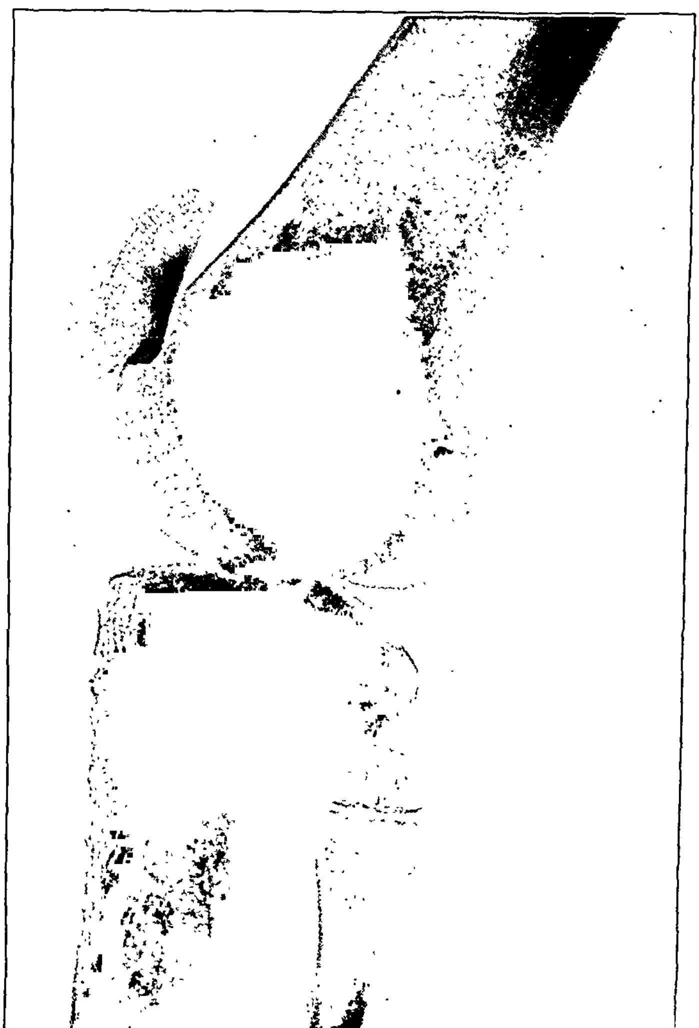


Fig. 10

Fractured lower pole of patella without displacement.

Fat Pad

The signs and symptoms of injury to the retropatellar fat pad will simulate a cartilage injury, but are generally less severe. There may be a history of pseudo-locking, in that full extension of the knee is not permitted, but there will be no history of unlocking, characteristic of the reduction of a displaced semilunar cartilage or loose body.

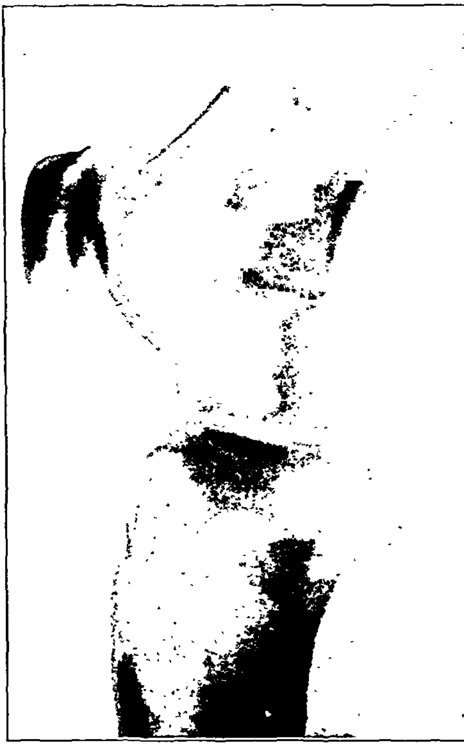


FIG. 11
An avulsed and displaced tibial spine, blocking extension of knee.

Local tenderness on pressure is often experienced on the joint line. The patient complains of his knee giving way, of having a knee he cannot trust. In the author's experience, this trouble with the fat pad is more common in patients over thirty or forty years of age. Cartilage tears are rare in children and in schoolboys, and are common between the ages of eighteen and thirty. In patients over thirty-five, there is reason to be suspicious of the diagnosis and the fat pad comes more into the picture.

Overuse Arthritis

There is one other type of knee which bears only a superficial resemblance to cartilage derangement, the diagnosis of which presents no real difficulty. This is what may be called overuse arthritis. By this is meant a knee, generally between the third and fifth decades, which stands up to ordinary use, but will not allow overuse. For example, a doctor takes his holiday and tries to play two or it may be three rounds of golf a day, with an occasional game of tennis. He gives his knee some slight and indefinite twist. It fills with fluid, and extension is painful and limited by a few degrees. The inner joint line is tender. He feels the knee will give way and he does not trust it. The x-ray may show some slight lipping, but no gross change. This is a common story.

Torn Crucial Ligament

The diagnosis of a torn crucial ligament presents no difficulty, and there are just two other conditions resulting from injury which should be mentioned,—namely, fracture of the patella without separation, and avulsion fracture of the tibial spine.

Fracture of the Patella without Separation

Figure 10 shows a fractured patella, sustained by a boy who damaged his knee while jumping; it is not an instance of accessory epiphysis. The accident was such as commonly produces a cartilage injury,—rotation strain, flexed knee, and weight on the leg as he landed. The

site of tenderness on pressure, the pain on voluntary extension, and the x-ray make the diagnosis easy.

Avulsion Fracture of the Tibial Spine

Avulsion fracture of the tibial spine with a varying amount of the articular surface of the tuberosity may resemble a cartilage injury, but, fortunately, the x-ray saves one from making a wrong diagnosis. The following case has already been reported [1], but it is of sufficient interest to warrant further reference.

While playing football, the patient ran with the ball, trod on it, and fell. His knee locked 30 degrees short of full extension. An attempt to manipulate it straight failed. Swelling came on rapidly, and there was pain on pressure on the joint line.

Ten days after the injury, when first seen by the author, both the history and the clinical examination would have implied a cartilage injury. The x-ray (Fig. 11) revealed an avulsion fracture of the tibial spine; a large fragment was displaced into the front of the joint and blocked extension. The knee was approached by the split-patellar route and the bone was gouged out from the head of the tibia, in order that the elevated fragment with its articular cartilage should be brought back into position. The lateral roentgenogram, taken some months later, showed the knee to be in full extension and that the bone block was no longer occurring.

The patient was playing first-class cricket the next season, and has regained practically the full use of the knee.

Removal of the projecting bone and articular cartilage in this case would have resulted in a knee with a very limited range of motion. The author has dealt with this type of fracture in three cases in which without the aid of the x-ray he might have wrongly diagnosed the injury as a lesion of the cartilage.

Other Conditions

Recurrent dislocation of the patella, joint disease, and other conditions may be mentioned, but are unlikely to complicate the diagnosis if the history is carefully taken and the clinical examination is adequate.

TREATMENT

When the diagnosis of the primary injury is in doubt, as at times it must be with all of us, it is wiser to wait than to advise operation. The knee should be treated symptomatically, then tried out with use and, if desired, free-standing gymnastic work. If the knee holds up, well and good. If it gives way and exhibits the syndrome of a recurrent cartilage displacement, an operation should be performed. If it recovers up to a point, but then exhibits the syndrome of capsular adhesions—pain and limitation of movement on forced flexion with rotation—it should be mobilized.

If one can be reasonably sure that a cartilage is torn and displaced, it is safer and better to remove it. The alternative treatment by manipulation is indicated if the disability is due to adhesions which are the results of sprain.

As has been stated, the difficulty lies in arriving at a certain diagnosis following the primary injury, and so we temporize. As we cannot see what has happened unless we look into the joint, it is obvious that any statistics as to the cures by manipulation must be fallacious. If the correct treatment of the primary injury, whether by manipulation or operation, be a matter of opinion, there can be no doubt that operation is required for a recurring derangement. A knee which has been subjected to repeated internal trauma is likely to be the site of osteo-arthritis, and every surgeon has seen the degenerative change following a history of repeated derangement. Again, the physical danger of the unstable joint, which may throw the patient down at any time and in any place, is an important factor to be considered.

THE TECHNIQUE OF OPERATION

We take for granted the usual careful preparation of the patient and rigid aseptic, non-touch technique. It is so important that it can never be too often repeated that the gloved finger is always open to suspicion and should not be put into the joint cavity, but, granted reasonable dexterity on the part of the surgeon, ligatures should be tied with forceps. It is equally important not to bruise and damage tissue by rough handling or heavy pulling on retractors. Extreme gentleness is just as important in dealing with a joint as with the abdominal contents. Anything which devitalizes tissue, by bruising or tearing, is bad surgery.

There is one point in the general theater technique that should be stressed,—namely, everyone in the theater should wear an efficient mask. The author has had one case of sepsis, the cause of which was difficult to ascertain. Two knee joints were operated upon in one afternoon. In one case the patient convalesced normally; the other patient had a severe

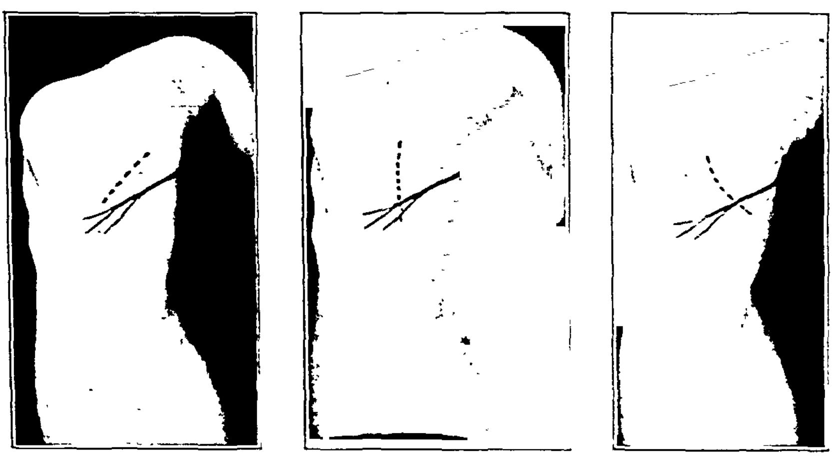


FIG. 12

The patellar branch of the internal saphenous nerve and the three standard incisions.

streptococcal infection—a direct wound infection. The fact that one patient escaped infection probably exonerates the catgut or the dressings. By chance that afternoon there were several people in the gallery, which at the author's hospital is not screened off from the well of the theater, and they wore no masks. Remembering that an agar plate can be infected at nine feet by the ordinary speaking voice, it is the writer's belief that this was the root of the infection. It is easy to be wise after the event and to say that there should be no talking, but since that date the author has insisted on masks being worn not only by those immediately taking part in the operation, but also by everyone in the gallery of the theater.

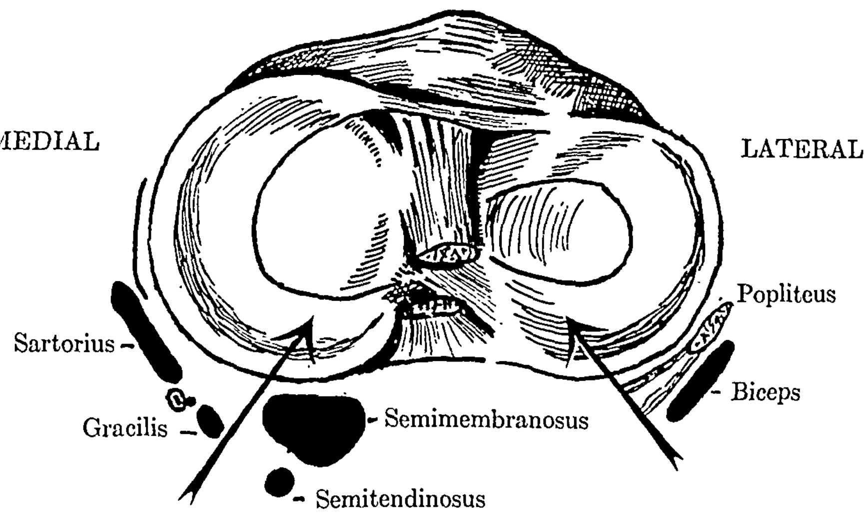


FIG. 13

Right tibia, showing the posterior approach to the knee joint from both sides.

The limb is first rendered bloodless by a tourniquet. The bloodless field admits of a better view and makes the operation quicker and easier. This does not give rise to a postoperative hemarthrosis, or to more pain afterward.

Whether the skin incision is oblique, vertical, or transverse is a matter of individual preference. The author prefers a simple oblique incision. It is wiser to avoid injury to the patellar branch of the saphenous nerve. Mr. Barrett, at St. Thomas's, carried out some dissections to determine the course of this nerve and writes as follows:

"It leaves the parent trunk soon after the latter has pierced the deep fascia on the inner side of the knee and runs vertically downward toward the joint line, accompanied by a small branch of the highest genicular artery. The joint line is crossed about two inches behind the inner edge of the patella and the nerve then turns forward and, running almost horizontally on the deep aspect of the fat in the superficial fascia, reaches the vicinity of the tuberosity of the tibia. Here it forms a plexiform network, the branches of which pass upward over the front of the patella and

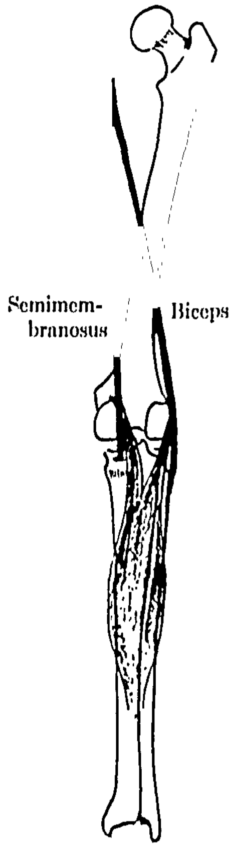


FIG. 14

The relation of the inner and outer hamstring muscles at the back of the joint.

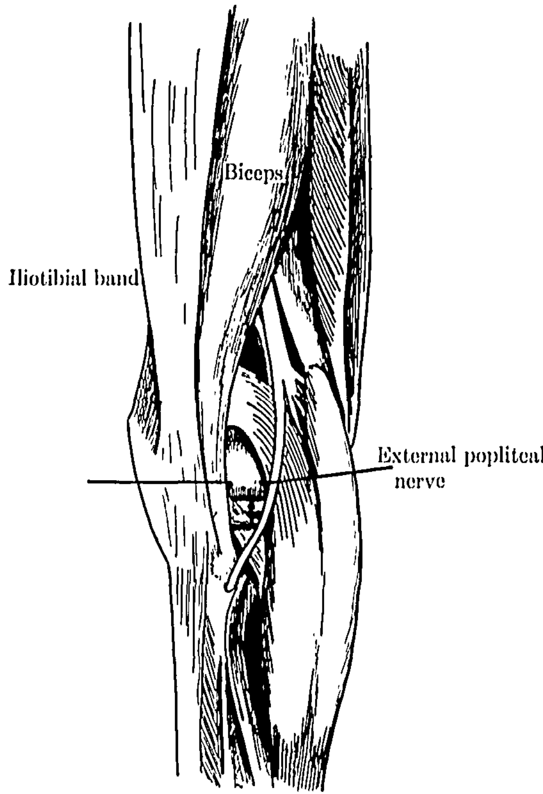


FIG. 15

Posterior view of left knee, showing the method of approach to the back of the outer cartilage.

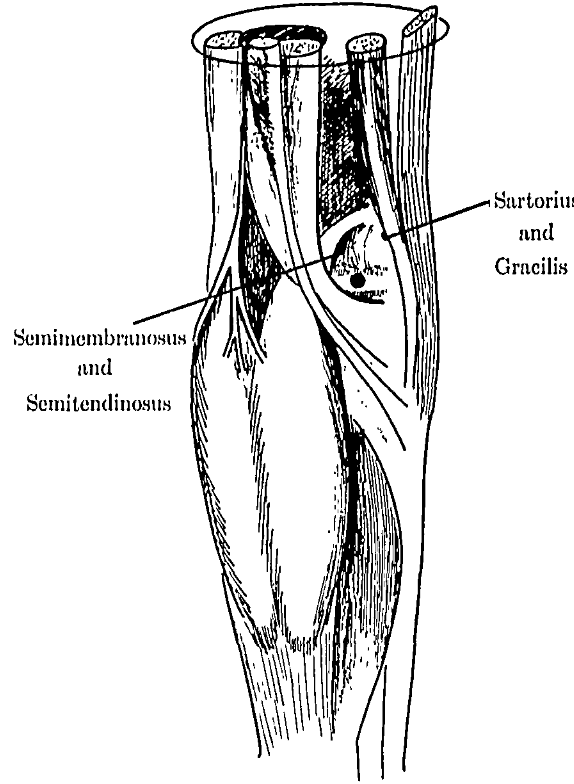


FIG. 16

Posterior view of left knee, showing how, with wide retraction of the hamstrings, the back of the inner cartilage can be reached.

laterally to anastomose with the terminals of the lateral femoral cutaneous nerve. To avoid *injury to the nerve, the incision must not be carried* below the level of the joint line and must not be prolonged backward toward the internal lateral ligament."

Naughton Dunn has pointed out that if the patellar branch of the internal saphenous nerve is cut, the end bulb is liable to become adherent to the scar and to be troublesome. In the author's series this has only occurred once. It is foolish to cramp oneself by not having a sufficient exposure, but the big incisions—either the split-patellar or the para-patellar incision—are not necessary. Although these long incisions may be useful in searching for a loose body or for operation on an avulsion fracture of the tibial spine, they give poor access for the removal of the semilunar cartilage.

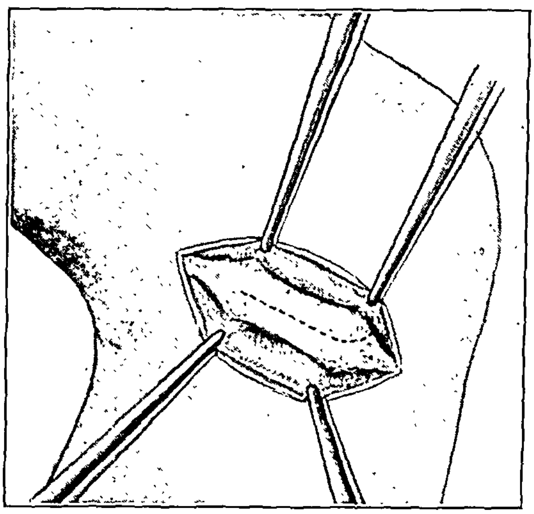


Fig. 17

Reflexion of the capsule from the extra-synovial fatty tissue when the knee joint is opened.

Big scars in synovial membrane are to be avoided. If necessary, multiple incisions can be used and may be needed for removal of loose bodies, or a second incision may be required to remove the posterior horn of the cartilage. The late Alwyn Smith of Cardiff was the first surgeon to the author's knowledge to use this incision; it has a definite place in the surgery of the knee joint, although one is rarely called on to remove the posterior horn.

The Posterior Approach

The surgeon must be prepared to explore the back of the joint, although this should not be part of the routine operation, as it is unnecessary and has certain obvious disadvantages. Figures 13, 14, 15, and 16* illustrate the easiest approach.

The objection to the posterior approach is that the view of the joint is restricted, and that the incision, necessarily longitudinal, has a tendency to become keloid. As with the anterior approach, the view seems to vary according to the individual patient,—some knees are fairly lax, some are tight.

This approach is most often needed for the removal of loose bodies in the posterior compartment of the knee.

After the skin has been opened and towelled off and the capsule divided, it is useful to dissect up this structure from the subjacent ex-

* The author is indebted for these drawings to Mr. Jeffery, of the Anatomical Department at St. Thomas's.

trasynovial fatty layer and membrane. This small refinement is of importance when one is removing a cartilage with cystic degeneration. Unless the capsule is stripped up and down off the cyst, closure becomes in some instances impossible. This has been found a useful routine procedure; it facilitates the closing of the synovial membrance and the capsule in two layers, which is the method adopted for closing the wound, and it makes for hemostasis. The synovial membrane must be opened above the cartilage in order that the state of affairs inside the joint may be clearly viewed.

Estimation of State of the Cartilages on Looking into the Joint

What one is most pleased to see at this point is the bucket-handle tear, with the central portion displaced, running backward across the joint. The removal of the displaced part and of the peripheral part as far back as convenient is then the wisest course. Some are content to leave the periphery of the cartilage, but this has been known to give rise to trouble, and it is better removed.

If the joint looks normal when opened, what should be done? The normal anterior third or half of the cartilage must be freed and pulled; then, if there is a posterior longitudinal split, the cartilage will be displaced across the joint. Although this procedure is recognized by many, it is not invariably adopted, and its importance should be stressed. If the posterior part of the cartilage is not torn—in other words, if the cartilage is normal—it will not be displaced when pulled. Unless the surgeon is prepared to detach the normal front end, he will often fail to recognize the posterior longitudinal tear. This tear is common, occurring in some 30 per cent. of the cases operated upon.

If the posterior half has failed to pull across the joint and is to be regarded as normal, what should be the next step? The anterior part, already detached by the surgeon, must be removed and the fixed posterior part left.

We are faced by the alternative that either we have made a wrong diagnosis or that the lesion is a torn external semilunar cartilage with symptoms referred to the inner side. One cannot see the external cartilage from the inner incision, so that the knee must be explored from the outer side as well. If the outer cartilage is normal, it should be left *in situ;* there is no need to detach a part, as is done on the inner side, in order to be sure that there is no posterior longitudinal tear. The outer cartilage is always more mobile than the inner, and we must not delude ourselves that a normally attached cartilage is loose or hypermobile.

The amount of the cartilage which can be removed via the anterior incision varies considerably with individual patients. In some, only a bare two-thirds can be removed; in others four-fifths, or nearly the whole, can be detached. With few exceptions, and these in a lax type of knee, the whole cartilage cannot be removed via the anterior route, unless the entire internal lateral ligament or a part of it is cut. In the author's

experience, the removal of this anterior part is all that is required in the majority of cases. In the series reported, only three times was it necessary to operate again to remove a posterior horn. This figure may be too low, but it is fair to say that rarely does the posterior horn give trouble; indeed, this follows from an understanding of the mechanism of the joint.

A word about the hypermobile cartilage should be added. What do we mean by this term? We have opened a joint; we find no tear in the semilunar cartilage; we put a blunt hook or an elevator under it; and we rock it. The cartilage moves, the external more freely than the internal. It is so easy to say that the cartilage possesses hypermobility and to remove it.

It is difficult to imagine a rupture of the coronary ligament which does not allow of repair. It is more logical to expect the tear to be repaired by organization of the hemorrhage and the formation of fibrous tissue resulting in adhesions. If we believe that this common cartilage injury is a fracture or tear of the semilunar cartilage itself and that the tear of the ligaments and attachments gives rise to adhesions, it is very hard to believe that *acquired* hypermobility is other than a very rare event and of unexplained pathogenesis.

In Table I, hypermobile and normal cartilages are placed together, as they form a group of operative findings from which it appears that the diagnosis was wrong, and that the cartilages did not require removal.

Retropatellar Fat Pad

Returning to the detail of the operation, the next structure in the joint to be inspected is the retropatellar fat pad, which the writer regards as important and which from the surgical point of view, particularly in England, has hardly received the attention it merits. This fat pad is not infrequently a source of trouble. It may be hard, fibrosed, and enlarged as the result of hemorrhage.

As already stated when discussing the mechanism, this fat pad is peculiarly liable to injury with rotation strains of the knee. The two tonguelike processes which project down and overlie the anterior horn of the semilunar cartilages are sometimes found to be red, inflamed, and thickened.

The removal of the enlarged fat pad will often give a satisfactory result. The removal of this mass seems to get rid of a mechanical obstruction and the scar necessarily following such removal is not a source of trouble.

Other Factors in Joint Involvement

One may find damage to the joint apart from injury to the cartilages, such as avulsion fracture of the tibial spine caused by the traction of the anterior crucial ligament, erosion of the articular cartilage, or one or another of the varieties of loose bodies.

Whichever of these conditions is found at operation, after closure of

the synovial membrane, capsule, and skin, a tight compression bandage is applied and the tourniquet is removed.

POSTOPERATIVE TREATMENT

The tight bandage is left *in situ* for twenty-four hours, and is then cut through without disturbing the underlying dressing.

The patient is encouraged to move the leg in bed, and to contract the muscles voluntarily. At the end of forty-eight hours, he should be able to raise the limb from the bed and to tighten and relax the quadriceps. Electrical stimulation of the quadriceps is commenced on the sixth day or earlier, and on the eighth day the stitches are removed.

The patient is up and walking on the tenth day. His early efforts at walking are supervised by the masseuse in order to teach him to take an equal length of stride with each foot and to bear his weight symmetrically. Small details of this kind are worthy of attention, as they hasten convalescence.

The need for postoperative treatment should be emphasized, and it should be borne in mind that the quadriceps is the only safeguard against rotation strain. If the muscle is much wasted, it should be built up before operation, as this helps a speedy recovery.

After operation, the muscle treatment must be carried out daily, as a routine. The recovery of movement is regained by the patient's own voluntary efforts. No passive or forced movements are needed, except in so far as the masseuse must see that rotation in both directions is assured during flexion.

RESULTS

A statistical table of end results has not been prepared. We are all familiar with the fact that the results are good *if the operation is meticulously performed and the after-treatment is adequate,—always provided that it was a torn cartilage which was the cause of the patient's disability.*

As already stated, in one patient in the series, septic infection, resulting in a stiff knee, followed the operation. In a few cases, a definite hemarthrosis occurred, sufficient to cause some anxiety for a day or two. A minor degree of swelling is not uncommon, but a swollen, tense knee should be a rare event if the suturing of the synovial membrane is carefully carried out. On one or two occasions only was there real cause for worry, and then the patient was taken to the theater on the second or third day, the knee was opened, the clot expressed, and the wound sewed up. This is the wisest plan. A search for a bleeding vessel would be unsuccessful, but it is unwise to leave the patient with a joint tense and filled with blood. Delay in relieving this condition has resulted in subsequent infection and disaster.

There was one other complication. Once, and that only recently, a thrombosis followed a simple removal of cartilage. This occurred on the twelfth day in the right leg on the side on which the knee had been op-

erated on. The thrombosis subsided in six weeks, and, as preparations were being made to get the patient up, the same thing occurred in the opposite leg. The patient was a man of forty-nine. He recovered eventually, but his convalescence was greatly prolonged.

The author has removed both cartilages from the same knee at one operation several times, and twice he has operated on both knees, removing a torn cartilage from each at one operation. These procedures give rise to no trouble, and do not complicate convalescence, excepting to prolong it slightly.

On an average, after a cartilage operation, the patients can return to office work in from two to three weeks and resume active game-playing in from six to eight weeks. There is generally some fluid in the joint when they commence to get about again, but this calls for no special care and subsides quickly. *If this fluid is excessive, it is advisable to apply a small* crêpe bandage for a week or two. If the fluid persists, it should be aspirated. Physical treatment, especially electrical stimulation of the quadriceps, aids recovery. Rowing on the sliding seat and bicycle riding are two excellent aids to strengthen the thigh muscles.

CONCLUSION

In dealing with internal derangement of the knee joint, the question with which we are mainly concerned is briefly: "Should this knee be operated upon?" The greater his experience, the more likely will the surgeon be to give the correct answer, so long as experience is based on knowledge of the mechanism of the joint, and the results of the varieties of trauma to which it is exposed.

1. Bristow, W. Rowley: Internal Derangement of the Knee-Joint. J. Bone and Joint Surg., VII, 413, Apr. 1925.

KNEE-FLEXION DEFORMITY FOLLOWING POLIOMYELITIS

Its Correction by Operative Procedures*

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A study of the records of the New York Orthopaedic Dispensary and Hospital shows that knee-flexion deformity after poliomyelitis was corrected by open release of the ligaments and muscles in forty-eight cases from 1919 to 1932 inclusive, by supracondylar osteotomy in twenty cases from 1922 to 1931, and by tibial osteotomy alone in three cases. The results of the different procedures were studied and compared with each other and with those of correction by the stretching method reported by Hughes and Risser.[1]

OPEN RELEASE

Forty-eight knees were treated by open release of contracted muscles, ligaments, and fascia. This group included both children and adults, and the duration of paralysis was over three years in each case. Practically all had a totally or partially paralyzed quadriceps muscle and an imbalance between the quadriceps and the hamstrings. The flexion deformity varied from 5 to 75 degrees, but in most cases it was 15 or 20 degrees. The follow-up period was usually more than two years after removal of the plaster, and varied from one to seven years.

Thirty of the knees extended to 180 degrees or more at the last examination, giving 62 per cent. excellent anatomical results. The stability of the knee on weight-bearing increased in twenty-six of those thirty cases. Fourteen other knees, or 30 per cent., had an improved extension, but not to 180 degrees, and eleven of these were more stable. Four cases, or 8 per cent., were classed as bad anatomical results because the flexion deformity recurred or was worse than before operation. Of the entire series, the stability was increased in thirty-seven knees, or 77 per cent.

A study of the cases showed that the anatomical and functional results were influenced by the same factors as in the series of knee-stretchings reported previously. The muscle imbalance in a growing leg tended similarly to cause a recurrence of the flexion deformity, unless there was enough soleus-muscle power or equinus without torsion to thrust the knee into extension or recurvatum on weight-bearing.

The cases are divided into groups according to age at operation, as in Table I. The lower extremities were growing moderately in Group I and rapidly in Group II up to the time of the end-result examination. In Group III the growth was slower, and in Group IV it had stopped.

Table I shows that the greatest number of bad results were obtained

* Received for publication July 31, 1934.

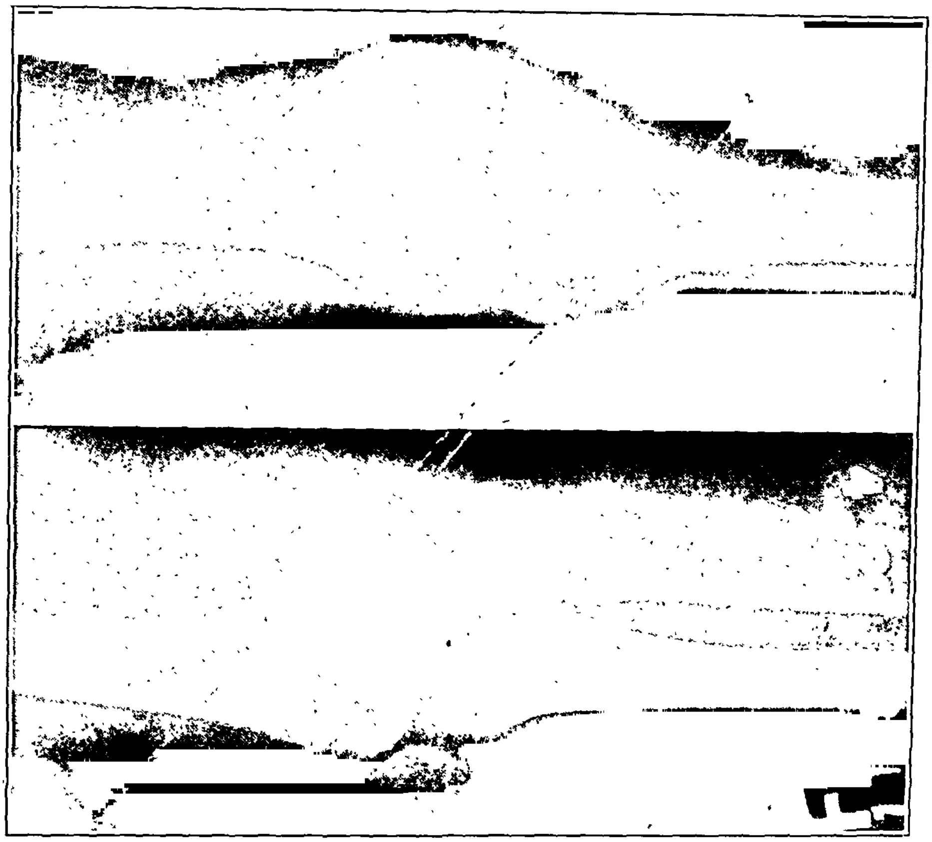

Fig. 2

Case 25. Result of open release of flexion, eighteen months after the removal of the plaster.

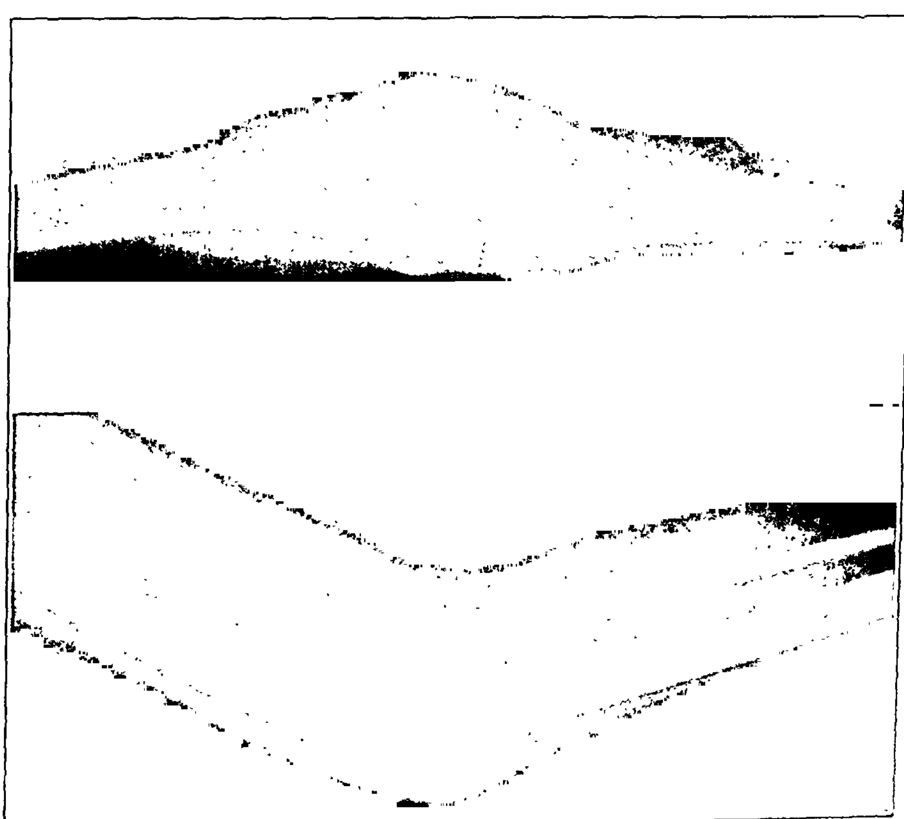

Fig. 1

Case 25. Preoperative knee-flexion deformity.

TABLE I

LATE ANATOMICAL RESULTS OF OPEN RELEASE IN AGE GROUPS

Anatomical Result	All Cases	Group I	Group II	Group III	Group IV
		Female: 3–5 years, inc. *Male:* 3–6 years, inc.	6–11 years 7–13 years	12–14 years 14–16 years	15 years + 17 years +
Excellent........ (to recurvatum or 180 degrees)	62 per cent.	33 per cent.	33 per cent.	67 per cent.	94 per cent.
Improved........ (less flexion deformity)	30 per cent.	67 per cent.	44 per cent.	33 per cent.	6 per cent.
Bad............ (same or worse)	8 per cent.	0	23 per cent.	0	0
Total...........	100 per cent. (48 cases)	100 per cent. (3 cases)	100 per cent. (18 cases)	100 per cent. (9 cases)	100 per cent. (18 cases)

in Group II in which leg growth was rapid, and the largest number of good results in Group IV, in which leg growth had ceased. Of the six cases with excellent results in Group II, a restretching was done in three. Of the other three patients, two had paralyzed hamstrings and one a fair quadriceps and an equinus position of the foot. In the one case in Group IV in which there was merely improvement, the affected leg was longer than the other one.

TABLE II

EFFECT OF FOOT-THRUST ON MAINTENANCE OF CORRECTION IN OPEN-RELEASE SERIES

Foot-Thrust *	Anatomical Result					
	Excellent		Improved		Bad	
	No.	*Per cent.*	*No.*	*Per cent.*	*No.*	*Per cent.*
Good.................. (Equinus without tibial torsion)	13	45	5	36	1	25
Fair or Poor............ (Equinus with torsion: dorsiflexion to 90 degrees with or without torsion)	12	41	4	28	3	75
Absent................ (Calcaneus)	4	14	5	36	0	0
Total..................	29	100	14	100	4	100

* By foot-thrust is meant the extensor force on the knee, which is transmitted upward from the foot in walking. (See Figures 5, 6, and 7 in article by Hughes and Risser[1].)

Table II illustrates that a limited dorsiflexion of the foot thrust the knee into extension, and did it better when there was no tibial torsion or rotation. The effect of equinus was demonstrated by Putti[2] in 1922.

In the present series, each patient with a good calf muscle had an equinus or 90 degrees' dorsiflexion, but many patients with limited dorsiflexion had weak calf muscles. Thus the groups with equinus and with strong calf muscles did not coincide. As many patients with poor calf muscles as with good calf muscles had excellent anatomical results, but more with good calf muscles than with poor calf muscles had recurrence of knee flexion. This may be explained by considering the function of the two chief components of the calf muscle. The soleus (assisted by the gastrocnemius) limits dorsiflexion of the foot, but its extending thrust on the knee is vitiated by the flexing pull of the gastrocnemius.

The immediate postoperative correction obtained and the length of time the extremity was immobilized in plaster were studied in each case, and the following were found to be essential for a good result: (a) in Group II, in which there was rapid growth, recurvatum for two to four months; (b) in Group IV, in which there was no leg growth, full extension for somewhat less than two months; (c) in the intermediate Groups I and III, no rule could be made. In general, the time in plaster did not need to exceed twelve weeks for growing legs and six weeks for non-growing legs.

The best correction which could be obtained after release and wedging depended largely on the operative technique. Many of the approaches were made through a posterior mid-line incision. Since 1931, the technique of Wilson[3] has been used. One or all of the following structures were released: iliotibial tract of fascia lata, biceps tendon, medial ham-

TABLE III

POSITION OBTAINED IMMEDIATELY AFTER OPEN RELEASE BY VARIOUS METHODS IN CASES OF MODERATE AND SEVERE DEFORMITY

Position Obtained	Operative Technique						
	Wilson (12 Cases)		Wilson plus (10 Cases)		All Others (25 Cases)		Total
	Preoperative Flexion Deformity		Preoperative Flexion Deformity		Preoperative Flexion Deformity		
	5°–15°	*20°+*	*5°–15°*	*20°+*	*5°–15°*	*20°+*	
Recurvatum...	7	1	5	1	8	2	24
Extension.....	4	0	2	2	3	11	22
Flexion.......	0	0	0	0	1	0	1
Total.........	11	1	7	3	12	13	47

strings, gastrocnemius, popliteus muscle, and posterior capsular ligaments. As far as it is known, the crucial and collateral ligaments were never disturbed. In the cases with more marked deformity, the plaster was applied with the knee in less than maximum correction after operation. The knee was wedged into recurvatum after a week, in order to prevent pressure sores, tension on incisions, and trauma to the popliteal vessels and nerves.

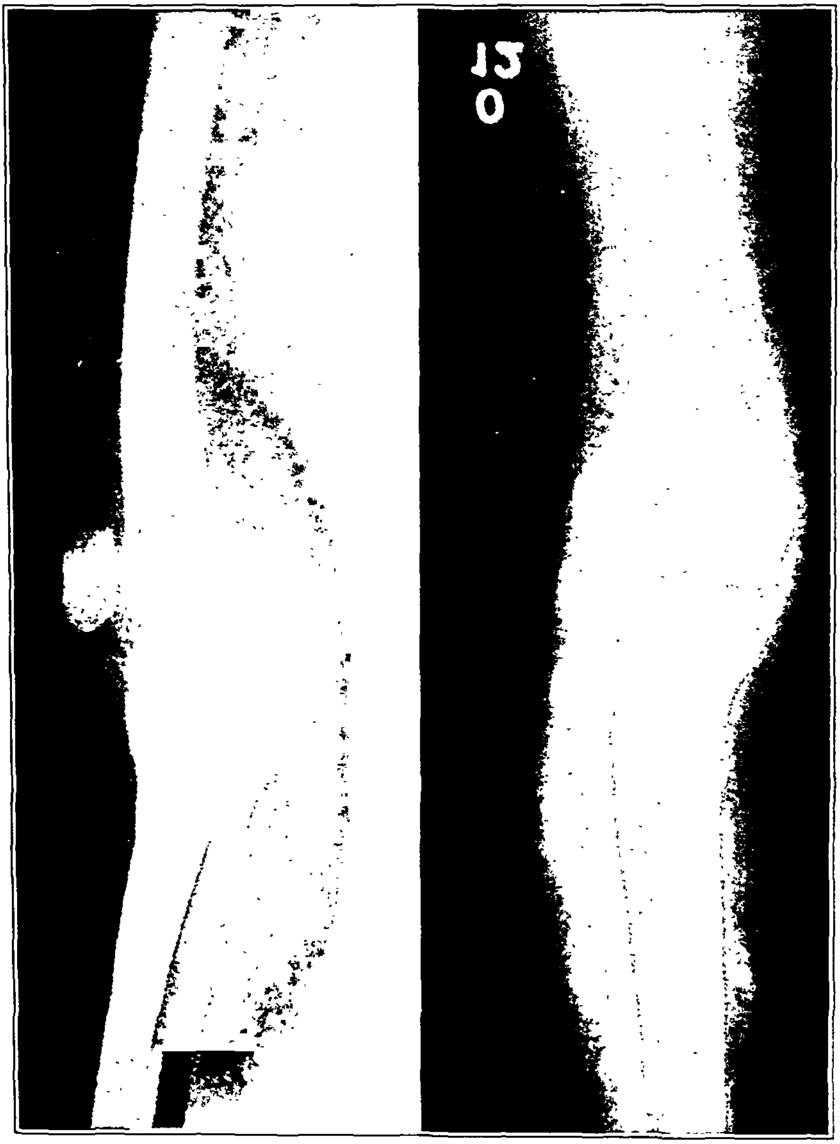

Fig. 3

Case 18. Result of open release and tibial osteotomy. Knee and tibial fragments in recurvatum.

The structures most commonly released by division, slipping, or lengthening were the posterior capsule, iliotibial band, and biceps tendon. The position obtained varied from definite recurvatum, as checked by roentgenogram, in twenty-four cases to full extension or only slight recurvatum in twenty-two cases and slight flexion in one case. Table III gives a comparison between the positions obtained by various procedures in moderate and severe cases. The total number of cases is forty-seven because in one the technique was not recorded. In the "Wilson plus" group, the periosteal attachment of the capsule was divided as well as elevated, which gave an additional 5 or 10 degrees of correction in the ten cases thus treated. The degree of deformity did not always indicate the procedure; this had to be decided by the operator. Table III, therefore, does not give evidence as to which is the best method.

Thus, it is the release of the three structures mentioned that is the essential factor, not the method by which they are released. It may be said, however, that the Wilson technique is simpler, gives better exposure of the contracted structures, and is less hazardous to the popliteal vessels and nerves.

FIG. 4

Case 32. Apparent posterior subluxation of the tibia, due to knee flexion, tibial osteotomy in recurvatum, and external rotation of tibia and fibula.

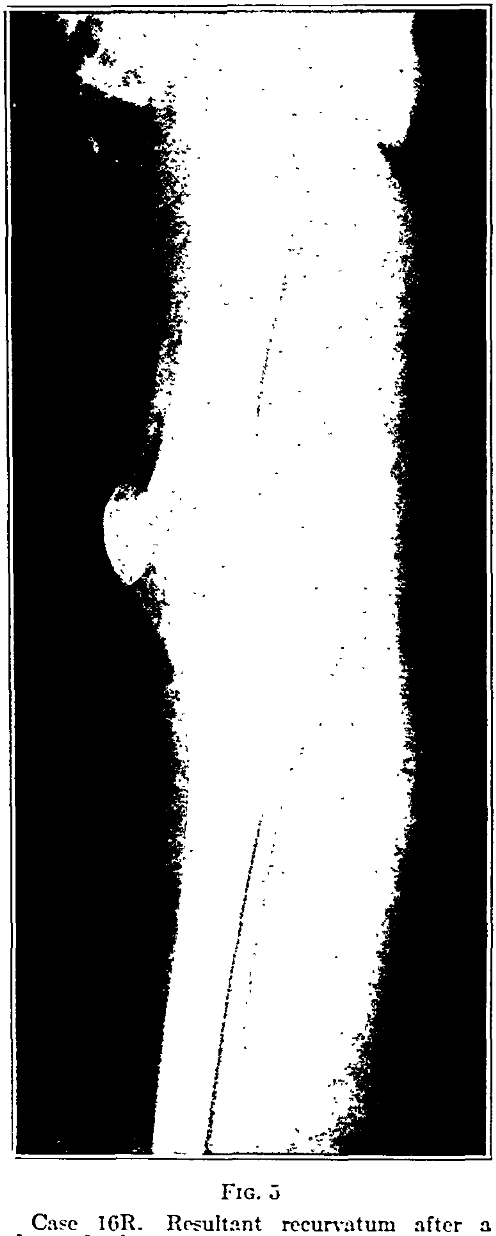

FIG. 5

Case 16R. Resultant recurvatum after a thorough knee-stretching and supracondylar osteotomy.

In none of the cases treated by open release was a supracondylar osteotomy performed to place the femoral fragments in recurvatum, but fourteen patients had tibial osteotomies for torsion or for knock-knee and torsion with a resulting recurvatum of the fragments. In these cases the recurvatum was considered as separate from and additional to that recorded at the knee joint itself. About the same percentage of patients in each group had such an osteotomy. Twelve of these fourteen patients had clinically a slight posterior subluxation of the tibia, such as that shown in Figure 4. This was not a true subluxation, nor was it in the eighteen other cases in which there was a posterior projection of the fibular head, due to an external rotation of the tibia, illustrated in Figure 2. Some of these other patients had osteotomies to correct torsion or knock-knee, but without anteroposterior angulation of the fragments. Many patients had subtalar arthrodeses. The effects of these other operations were shown in the alignment of the extremities at the final examination.

Complications were infrequent, and there were no fatalities. There were no wound infections, but one patient had a hematoma with a secondary sloughing of one wound and a skin graft was required. There was one case of tourniquet paralysis lasting ten weeks. Stiffness of the knee at last examination was rare. The range of motion was more than 120 degrees in all but seven knees, and less than 90 degrees

in two knees, one of which had 70 degrees and the other 45 degrees of motion. One patient with totally paralyzed hamstrings had a marked lateral relaxation and 30 degrees' recurvatum. Five knees with poor hamstrings had a slight relaxation. Seven knees had mild symptoms of strain. These facts were taken into consideration when evaluating the functional results.

In the absence of quadriceps power, the chief stabilizing factors were recurvatum, gluteus-maximus power, equinus without tibial torsion, and a strong calf muscle.

Three patients had release of hip flexion by open operation on the same side, and, at last examination, correction was complete in one case and partial in two. Twenty other patients showed a spontaneous loss of hip-flexion deformity,—a complete loss in fourteen cases of moderate severity and a partial loss in six cases of marked degree. In all of these cases there was a complete or partial correction of the knee-flexion deformity. In some of them the iliotibial band was divided, and in others it was not. The weight of the plaster may have been instrumental in stretching the hip.

TIBIAL OSTEOTOMY ONLY

In three cases a tibial osteotomy was performed with the fragments in recurvatum, but no release or stretching of the knee joint was done. The first knee which was operated upon became unstable again, but a satisfactory end-result examination could not be obtained. In each of the other two cases, examined two and one-half and ten years later, respectively, the knee maintained slight recurvatum, but showed a marked apparent posterior subluxation of the tibia. One was in a slowly growing extremity and the other in a non-growing extremity. The stability of

TABLE IV

LATE ANATOMICAL RESULTS OF SUPRACONDYLAR OSTEOTOMY IN AGE GROUPS

Anatomical Result	All Cases	Group I	Group II	Group III	Group IV
		Female: 3–5 years, inc. *Male:* 3–6 years, inc.	6–11 years 7–13 years	12–14 years 14–16 years	15 years + 17 years +
Excellent........ (to recurvatum or 180 degrees)	45 per cent.	0	22 per cent.	100 per cent.	75.0 per cent.
Improved........ (less flexion deformity).......	10 per cent.	0	11 per cent.	0	12.5 per cent.
Bad............. (same or worse)	45 per cent.	100 per cent.	67 per cent.	0	12.5 per cent.
Total....	100 per cent. (20 cases)	100 per cent. (2 cases)	100 per cent. (9 cases)	100 per cent. (1 case)	100 per cent. (8 cases)

both of these knees remained poor, mainly because of lateral relaxation. One knee was fused later. These knees showed good anatomical but poor functional results.

SUPRACONDYLAR OSTEOTOMY

Twenty patients were subjected to supracondylar osteotomies with the femoral fragments placed in recurvatum; in some cases the knee was stretched. None had open release of the knee, but some had tibial osteotomies which produced recurvatum. This series includes three supracondylar fractures,—two occurring at the knee-stretching and one shortly after the removal of plaster.

The age at operation varied from five to twenty-five years. The flexion deformity varied from 5 to 20 degrees. The recurvatum at the osteotomy site was from 5 to 30 degrees.

The period of follow-up was from one to seven years, the average time after removal of plaster being three and one-half years. At the last examination, nine of the knees showed a clinical or resultant extension to 180 degrees or more, giving 45 per cent. excellent anatomical results. The stability of the knee on weight-bearing increased in five of these nine cases. Two others, or 10 per cent., had an improved extension, but not to 180 degrees; one was improved functionally; and the other showed no functional improvement. Nine cases, or 45 per cent., were classed as bad anatomical results because the flexion deformity recurred or was greater than before operation. After deducting the knees which showed lateral relaxation and symptoms of strain, it was found that there was a functional improvement in seven cases, or 35 per cent. of the entire series.

TABLE V

COMPARISON OF LATE ANATOMICAL AND FUNCTIONAL RESULTS OF EACH PROCEDURE

Procedure	Number of Cases	Anatomical Result				Function	
		Correction					
		To 180 Degrees or More	Decreased Flexion Deformity	Same or Increased Flexion Deformity	Apparent Subluxation of Tibia	Improved	Not Improved
Tibial osteotomy alone	2	100 per cent.	—	—	100 per cent.	0	100 per cent.
Open release . . .	48	62 per cent.	30 per cent.	8 per cent.	60 per cent.	77 per cent.	23 per cent.
Supracondylar osteotomy	20	45 per cent.	10 per cent.	45 per cent.	5 per cent.	35 per cent.	65 per cent.
Stretching and wedging *. .	111	33 per cent.	42 per cent.	25 per cent.	6 per cent.	54 per cent.	46 per cent.

* This procedure has been described in a previous report.[1]

Fig. 6

Case 1R. Showing recurrence of flexion deformity after supracondylar osteotomy.

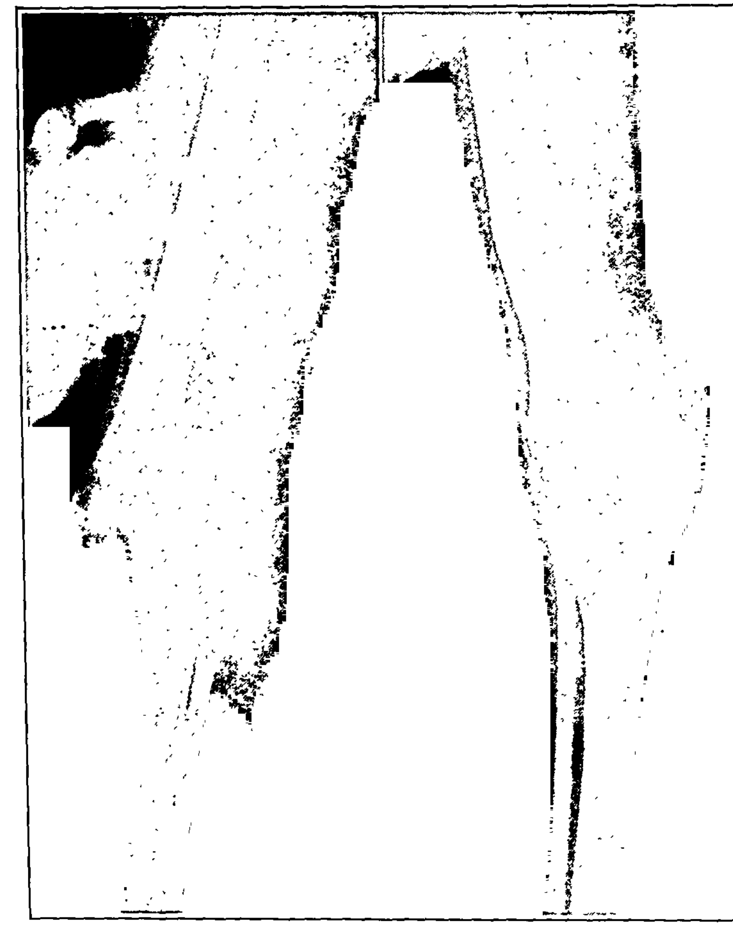

Fig. 7

Case 3R. Flexion deformity after supracondylar fracture, osteotomy, and tibial osteotomy. In each case the fragments were in recurvatum. Open release of the knee was not done.

As in the open-release series, the worst anatomical results were obtained in the rapidly growing extremities. This is illustrated in Table IV.

All but four of the patients in whom excellent results were obtained had a thorough stretching of the knees, signifying that the knee joints themselves were stretched to recurvatum in growing legs or to full extension in legs of completed growth, for six to twelve weeks. Each of the four whose knees were not well stretched had the femoral fragments in marked recurvatum; two of them were in Group IV and the other two had poor hamstrings. In these four cases, the knees were relaxed laterally. The one patient in Group II who showed improvement did not have a complete knee-stretching, but had a supracondylar fracture, a supracondylar osteotomy, and a tibial osteotomy, all with the fragments in recurvatum (Fig. 7). Every patient who had a thorough knee-stretching had an excellent or improved anatomical result.

In the only two cases of calcaneus deformity of the foot bad anatomical results were obtained. It happened that all of the patients in Group II (rapid growth) had only poor to fair foot-thrust,—that is, none had equinus without tibial torsion. This was another reason for the many bad results in that age group. A good foot-thrust was not so essential in Group IV (no growth), in which the patients with excellent anatomical results lacked this factor.

A better correction of knock-knee was obtained by osteotomy in Group IV, in which the knock-knee was associated with flexion. This fact again demonstrates the prime importance of growth in the cases of marked muscle imbalance.

Other operations which were performed to correct the alignment of the tibia or foot will not be discussed, but their results are included.

Just as in the cases treated by open release and by stretching and wedging in plaster, the anteroposterior stability of the knee was enhanced by recurvatum, a good gluteus maximus, equinus without tibial torsion, and a good calf muscle.

COMPARISON OF PROCEDURES

Table V shows the anatomical and functional results obtained by the different methods, based on the standards which have been described. The knees stretched and wedged were those reported previously.[1] It was also noted that the correction obtained before immobilization was in general better after open release than after stretching.

The distribution of cases by age groups was significant. The method which seemed to secure a greater percentage of better anatomical results was used in a larger number of older patients with no growth of the extremities. The procedures which were apparently less successful in preventing a recurrence of the deformity were employed in younger patients in whom there was rapid growth of the extremities.

In each age group, the open-release method produced a much greater percentage of permanent corrections than the other methods. The num-

ber of cases in which tibial osteotomy alone was performed (two cases) is too small for comparison in this respect. In Group II, supracondylar osteotomy produced 67 per cent. bad anatomical results; stretching, 33 per cent.; and open release, 23 per cent. However, it must be recognized that more of the cases treated by osteotomy in that group of rapid growth lacked a good foot-thrust.

No matter what method of correction was employed, the same factors influenced the anatomical and functional results. Some of these factors were determined by other operative procedures, which were different in each series of cases.

CONCLUSIONS

1. *General:*

(*a*) Better final correction of knee-flexion deformity was obtained in extremities which were not growing. Rapid growth was the chief factor causing a recurrence of the deformity.

(*b*) A good foot-thrust was important in forcing the knee into extension or recurvatum. Foot-thrust was best when there was an equinus or a strong soleus muscle, without tibial torsion.

(*c*) Good, lasting correction was obtained by the different methods in the following order: tibial osteotomy (only two cases), open release, supracondylar osteotomy, and stretching.

(*d*) Functional improvement was obtained in the following order: open release, stretching, supracondylar osteotomy, and tibial osteotomy.

2. *Open release:*

(*a*) Better anatomical results were obtained by this procedure than by the other methods in corresponding age groups.

(*b*) The release of posterior capsule, iliotibial band of fascia lata, and biceps tendon was most essential.

(*c*) Immobilization in recurvatum for twelve weeks was needed in rapidly growing legs, but 180 degrees' extension for six weeks was sufficient in legs having full growth.

(*d*) Tibial osteotomy in recurvatum produced more recurvatum in the end, but was one cause of apparent subluxation. The other chief cause was rotation of tibia and fibula.

(*e*) The functional results were better than those in any other series.

3. *Supracondylar osteotomy:*

(*a*) Most of the good anatomical results were obtained in those cases in which the knees were thoroughly stretched also.

(*b*) The anatomical and functional results were not as good as those obtained by open release.

4. *Clinical posterior subluxation of the tibia:*

This condition, which was only apparent, was uncommon in the supracondylar-osteotomy series, but frequent in the open-release series, in

which many patients had tibial osteotomies in recurvatum. This subluxation did not endanger the stability of the knee.

5. *Stability:*

The weight-bearing property of the knee, with a completely or partially paralyzed quadriceps and some hamstring power, depended on: (*a*) recurvatum, (*b*) gluteus-maximus power, (*c*) foot-thrust.

6. *Functional result:*

The functional result was frequently vitiated by lateral relaxation and strain after supracondylar osteotomy, but rarely after stretching or open release.

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SPONDYLOLISTHESIS WITHOUT SEPARATE NEURAL ARCH (PSEUDOSPONDYLOLISTHESIS OF JUNGHANNS)

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Since 1926, the United States National Museum has been receiving large quantities of Eskimo skeletal remains from all parts of Alaska. For the most part, these remains are from village sites where there was little contact with white people, and some may even be prehistoric. This unique collection offers a fascinating field of study both in anthropology and pathology for the following reasons: It represents an old inbred population, living in a cold, wet climate, and subsisting on a limited but apparently quite adequate diet in which sea-food predominated.

The writer has had the opportunity of examining this material and has directed his attention from the first to the spinal column on account of the frequent occurrence of separate neural arch in the lumbar vertebrae. This anomaly, which is the predisposing anatomical factor responsible for true spondylolisthesis, was found to be present in one or more segments of the spinal columns of thirty-nine out of ninety-six males and thirty-four of ninety-one females from north of the Yukon—40.6 per cent. and 37.4 per cent., respectively[1]. Its presence was also noted in twenty out of 115 males and thirteen of 110 females from the Yukon and south—17.4 per cent. and 11.8 per cent., respectively[2]. The meaning of this marked difference in frequency of the anomaly between the two regions is still a puzzle, but may point to a difference in racial composition.

At the time the above reports were prepared the writer was unable to prove on the basis of the accompanying arthritic changes that spondylolisthesis had occurred in any case of separate arch. Since then Congdon [3] has described similar vertebrae found in American Indian skeletons, some of which he claims had undergone spondylolisthesis. The writer feels that Congdon has not proved this point because he has failed to show that such changes are limited to vertebrae with separate arches. Furthermore, he has left out of consideration the intervertebral discs when articulating the defective vertebrae with the sacra. In view of the marked lipping that can be found in spines without separate arches, it was felt that a record should be made of such changes in both normal and anomalous spines. This study is still in progress, and, although it has somewhat more anthropological than clinical interest, nevertheless it may throw some light upon etiological factors.

The present report concerns a related phase of this study, unanticipated in the beginning, but seemingly of considerable clinical interest. In the course of making detailed observations on the Eskimo spines, two cases were seen in which spondylolisthesis had occurred without separation

in the arch, simply through arthritic erosion of the articular facets. A third case was encountered among the skeletons of Pueblo Indians examined for comparative purposes. Since it is possible in these cases to make an accurate reconstruction merely through the interrelations of the articular facets, the secondary arthritic changes can be evaluated. Moreover, this type of displacement, to which Junghanns[4, 5] has given the name "pseudospondylolisthesis," is of sufficient rarity (certainly among primitive peoples) to warrant the presentation of any evidence bearing on its nature. One of Junghanns' roentgenograms[4], taken after the spine had been sectioned in the sagittal plane, is reproduced in Figure 1 for comparison with the new cases (Fig. 2).

It is hoped that the accompanying illustrations of the new cases (Figs. 2 to 5) will serve in the place of detailed descriptions. Attention needs to be directed only to the alterations in shape of the neural canal, resulting from erosion and lipping of the superior articular facets (Figs. 3 and 4). This point is not brought out in Junghanns' study. It seems probable that here, unlike in true spondylolisthesis, there may be symptoms of spinal-nerve compression before much displacement has occurred[6].

FIG. 1

Roentgenogram of the spine of a female fifty-eight years old, showing "pseudospondylolisthesis" of the fourth lumbar vertebra. The arrow indicates narrowing of the space between the superior articular processes and the vertebral body. Ullmann lines[9] have been added to show the degree of subluxation. *(Reproduced from Arch. f. orthop. u. Unfall-Chir., XXIX, 123, 1931, by courtesy of Julius Springer.)*

Aside from the articular facets, hypertrophic arthritis appears in the form of lipping of the vertebral bodies. Since this lipping might be expected to have resulted in some degree from the vertebral displacement, the amount of lipping for the sacrum and each of the lumbar segments has been summarized in Table I. The scale of change was determined on the basis of the most extreme lipping seen in these racial groups. It has been found from observations on the spinal columns in a large series of adult Eskimos (ninety-two males and eighty-five females) that the order of involvement of the several lumbar-body borders, beginning with the most marked, is as follows: upper border of fourth lumbar, upper fifth lumbar, upper third lumbar and lower fifth lumbar (nearly equal frequency), and the remaining borders in general much less affected, especially the first and second lumbar. With this in mind, it will be seen that the three spines with pseudospondylolisthesis are not remarkable for the degree of lipping present. In addition, it is impossible to deter-

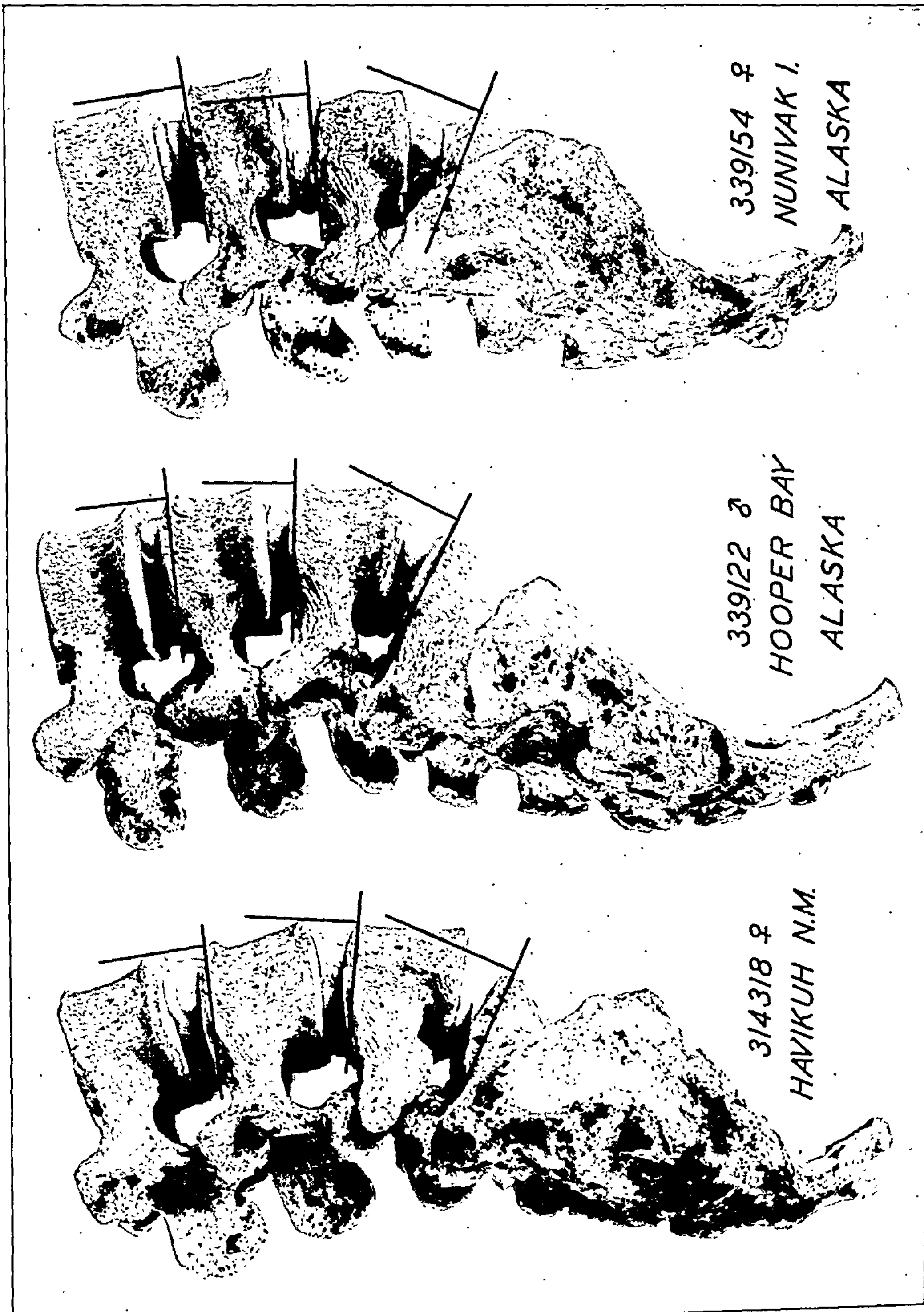


Fig. 2

Restoration of actual articulations between the last three lumbar vertebrae and the sacrum in three cases. Ullmann lines[9] show the degree of subluxation.

mine whether any of the lipping is secondary to the vertebral displacement.

The number of cases of pseudospondylolisthesis thus far studied is still too few to permit the establishment of approximate sex and race frequencies. However, in contrast to the true form, it seems certain that pseudospondylolisthesis is less common and is limited by its nature to the upper age periods. Both conditions occur in the fourth and fifth lumbar vertebrae of the two sexes, but the true form is more common in the fifth lumbar vertebra of males, while the other form is (probably) more frequently found in the fourth lumbar vertebra of females.

Regarding the etiology of pseudospondylolisthesis, Junghanns could not decide whether an abnormal static condition produced the arthritis or vice versa. His remark on this point (p. 124[4]) may be freely translated as follows:

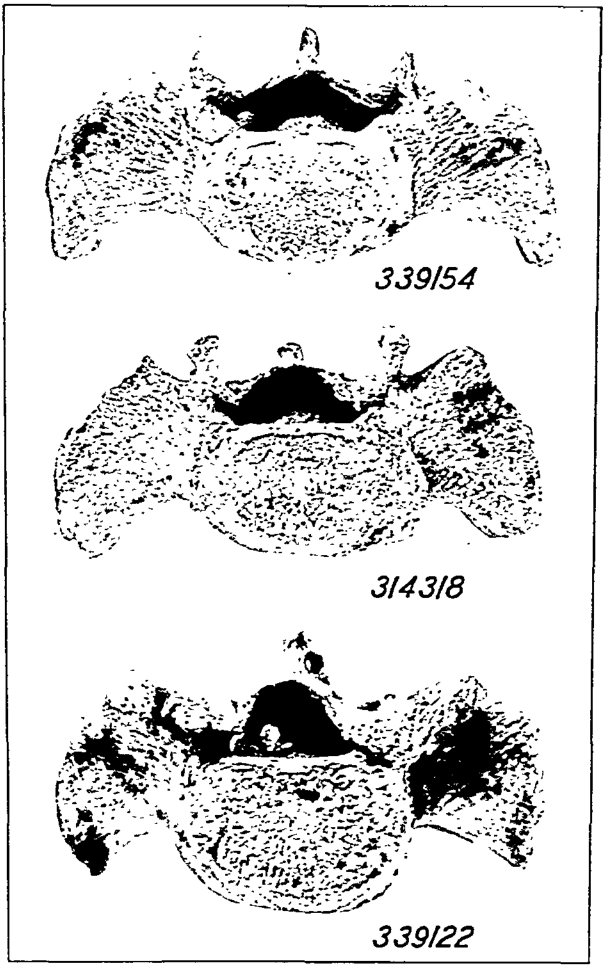


FIG. 3

Superior surfaces of sacra shown in Fig. 2. The articular facets of 339154 are normal; whereas those of the other two specimens show arthritic changes. Note alterations in the contour of the neural canal.

It is conceivable that the abnormally great angle between the pedicle and the inferior articular process in the case of a pseudospondylolisthetic vertebra represents one of the many malformations of the lower lumbar vertebrae, and that in consequence there exists abnormal static relationships which secondarily bring about the arthritis deformans of the corresponding small joints. On the other hand, the view cannot be set aside that the arthritis deformans of the small joints represents the original cause and as a result of the erosion of the joint surfaces there occurs the leveling of the articular spaces and the inferior articular processes. However, it appears

singular that most of our cases of pseudospondylolisthesis concern the fourth lumbar vertebra. An isolated, strongly developed arthritis of the small vertebral joints is more plausible at the point of greatest stress of the vertebral column—that is, between the fifth lumbar and the sacrum; whereas the explanation of such a condition at the interval between the fourth and fifth lumbar offers difficulties.

The observation that an abnormally great angle exists between the pedicle and inferior articular process in this type of displaced vertebra is probably correct, yet this condition is undoubtedly the product of erosion of the inferior articular facets. Considering the great range of normal variation in the lumbosacral region, it does not seem reasonable that a relatively minor variation of this sort could produce so much instability.

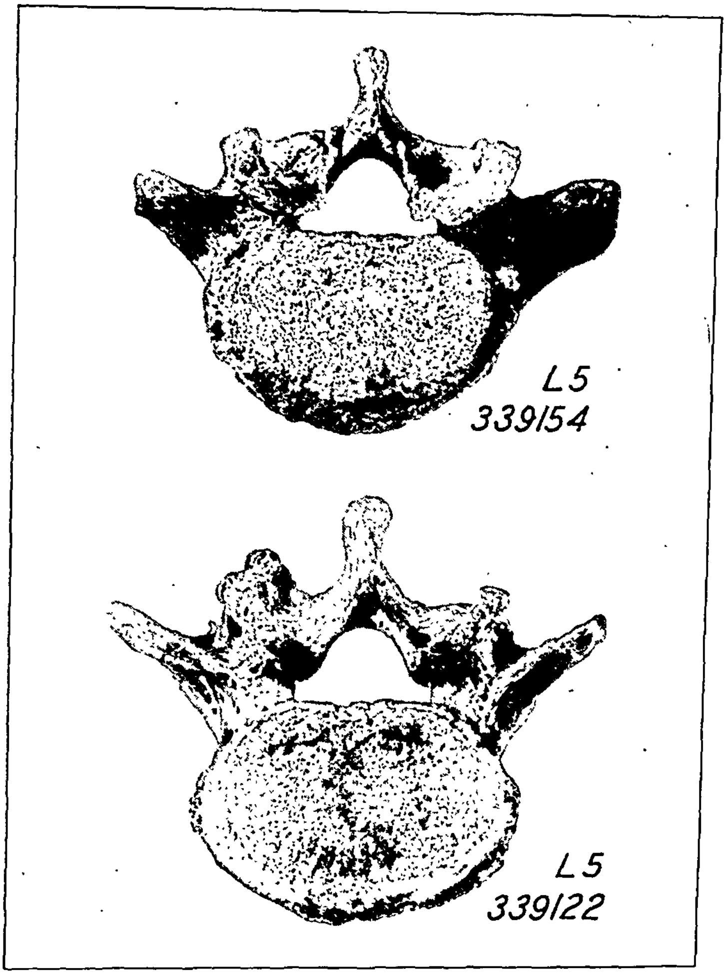
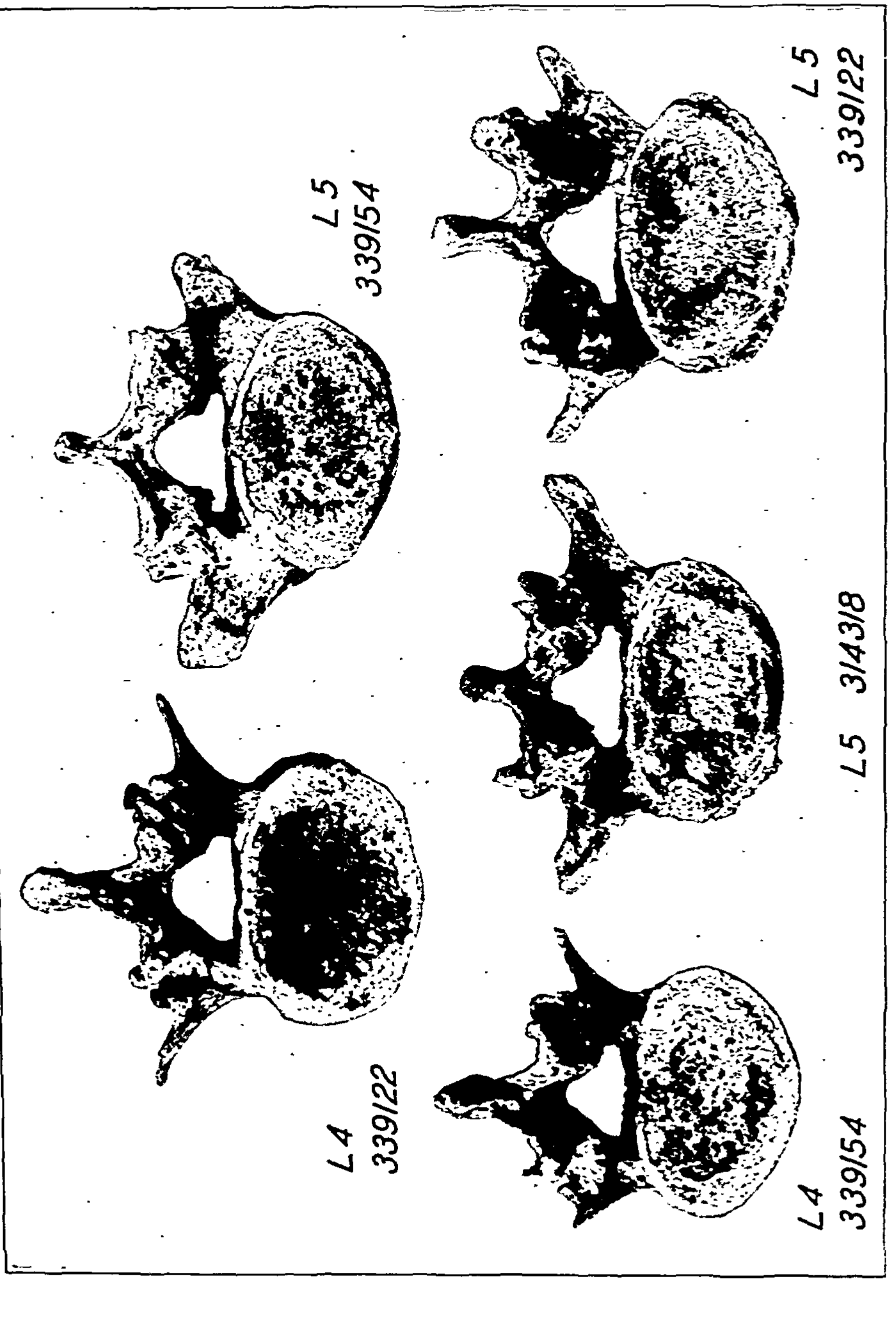


FIG. 4

Superior surfaces of two of the fifth lumbar vertebrae shown in Fig. 2. The superior articular facets of 339122 are normal; whereas those of 339154 show arthritic changes. Note alteration in the contour of the neural canal in 339154.

Before much insight into the causes of this condition can be gained, it is necessary to know the relative susceptibility to arthritic changes of the articular facets at different levels. In the series of Eskimo spines already referred to, the writer has recorded the positions of facets showing eburnation, lipping, etc. Without going into the details, it can be definitely stated that several distinct peaks of susceptibility exist along the course of the column. One of the major peaks occurs at the second, third and fourth cervical joints; another is between the ninth, tenth, eleventh, and twelfth thoracic joints; and minor peaks occur at the seventh cervical and first thoracic, fourth and fifth thoracic, and fourth and fifth lumbar and first sacral. Incidentally, involvement of the fourth and fifth lumbar is slightly more frequent than that of the fifth lumbar and first sacral.


L4
339/22
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L5 3/43/8
L5
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TABLE I

DEGREES OF VERTEBRAL LIPPING IN THE LUMBOSACRAL REGION OF THE THREE SPECIMENS REPORTED *

Number	Border	Vertebral Segment					
		First Sacral	Fifth Lumbar	Fourth Lumbar	Third Lumbar	Second Lumbar	First Lumbar
314318	Upper	++	++	++	++	+	?
	Lower		+	++	+	–	?
339122	Upper	+	–	++	–	–	–
	Lower		++	–	+	–	–
339154	Upper	–	+++	++	+	–	–
	Lower		–	–	–	+	–

* Degrees are represented as minus, one, two, three, and four plus (? = damage). The most extreme change (four plus) observed in these racial groups is not represented in these specimens.

Examination of a smaller series of Pueblo Indians (forty-two males and forty-eight females) suggests that, except for a smaller peak in the lower thoracic region, the same pattern exists in this group. Another interesting observation, true of both series, is the fact that, although in general the two sexes are about equally susceptible, the incidence favors the females as regards the lower lumbar region.

The important point is that the facets of the lumbar region are less frequently involved than certain other sections of the column; whereas this region is the most common site of lipping of the vertebral bodies. Unlike vertebral lipping, however, involvement of the articular facets is not so constant or so intimately related to age. On the other hand, the locations of the peaks of susceptibility suggest some connection with spinal mobility. This further suggests that trauma is a factor, although probably only a predisposing factor. That trauma is merely a predisposing factor is suggested by the fact that, of the facets entering into the joint between two vertebrae, often one side only is involved. Considering the nature of the joint structure, it is difficult to see how one side can suffer more trauma than the other. Also, in the series of spines studied, there was no clear-cut involvement of the facets of one side in excess of the other. It must be remembered, however, that one-sided occupational movements are not as common in primitive as in civilized peoples.

So far few studies have been made of the movements in the vertebral joints, especially in the lumbar region. Dittmar [7], on the basis of one subject, claims equal movement of the small lumbar joints in all directions, although the bodies of the fourth and fifth lumbar were observed to move more than those of the first three. Judging from the anatomical variabil-

ity in this region, joint motion must also be variable. This is a desirable field for further research.

As for the immediate or exciting factor in pseudospondylolisthesis, that cannot be determined from the material at hand. It is conceivable that a joint normally under considerable stress, as one of those in the lower lumbar region and especially in a female, might break down after middle life, if, to mention only one of the suggested causes, its blood supply were interfered with [8]. Once erosion of the articular surfaces has set in, the stress upon the vertebra acts as a matter of course to slowly displace it in relation to the segment below.

It is to be hoped that clinical records will soon be made available so that the impressions here reported, based solely upon anatomical specimens, can be checked.

SUMMARY

In a collection of Eskimo and Indian skeletons, three specimens were found with first-degree or second-degree spondylolisthesis without separate neural arch. This type of vertebral displacement is shown to be due to arthritic erosion of the articular facets and, therefore, identical with the so called "pseudospondylolisthesis" of Junghanns. Because of the infrequency of this condition, a large series of adult spines of these racial groups has been studied with the aim of detecting possible etiological factors.

On the basis of the usual distribution of lipping of the vertebral bodies, it is pointed out that displacement is apparently not responsible for the lipping in the present cases. A study of the distribution of arthritic facets shows that other regions of the column may be more frequently involved than the lumbar. Within the lumbar region the frequency favors the fourth and fifth lumbar joint and the female sex. The locations of arthritic facets suggest that trauma connected with spinal mobility may be a predisposing factor. Clinical data will be required to determine immediate factors.

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VOLKMANN'S CONTRACTURE*

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The purpose of this paper is to present an orderly progressive series of events which have led the Fracture Service of the Massachusetts General Hospital to certain conclusions concerning the causative factors in the production of Volkmann's contracture.

Volkmann's contracture was first described by the man after whom it was named, Richard von Volkmann. In 1875, he described a contracture of the hand which he believed was due to tight bandaging. He thought that it was a very serious condition, often requiring amputation.

In 1881, he wrote a classical article dealing with contracture of the hand. He felt that this difficulty was due to the shutting off of the blood supply, plus the obstruction of the venous outflow. He thought the hard, boardlike condition which followed was similar in nature to rigor mortis. Because the contracture and paralysis occurred immediately following the injury, he did not believe it was due primarily to a nerve injury, for in nerve injuries the contracture occurred at a later date. He described the means and methods of overcoming this contracture by forcible extension of the fingers. Since that time there have been many writings on the subject.

Volkmann's contracture is associated with injury of the elbow region. In 80 per cent. of the cases it follows a supracondylar fracture of the humerus. In 20 per cent. of the cases there is no fracture, the contracture being due to a crushing injury with internal hemorrhage and resulting pressure.

It seems that the anatomical structure of the forearm and elbow is necessary to produce Volkmann's contracture. The forearm and elbow are encased in a firm, resisting fascial envelope. Hemorrhage within this envelope cannot escape, and tremendous pressure results. Furthermore, in certain cases the anatomical structure contributes an added factor,—the tendon of the biceps muscle passes downward, inserting in the radius below. From this tendinous insertion springs a narrow fibrous band, the bicipital fascia, which crosses the elbow joint obliquely inward, fading out in the flexor muscles of the lower arm. The brachial artery passes directly beneath the fascia. The bicipital fascia may be put under great tension, due to intrinsic hemorrhage, oedema, and swelling of the tissues.

To appreciate the pressure at times exerted on the brachial artery beneath, one has only to see the tense fascia and the liberation of tissues resulting upon incising it. We may have tremendous hemorrhage with extravasation of blood into the tissues of the upper arm; we may have much

* Read before the Twenty-Fourth Clinical Congress of the American College of Surgeons, Boston, October 1934.

more extensive hemorrhage in other parts of the body, without producing a condition comparable with Volkmann's contracture. It is because of the peculiar anatomical structure described that pressure within the fascia sufficient to produce the condition is possible. Although a number of cases simulating Volkmann's contracture of the gastrocnemius muscle have been reported, we have never observed any.

Numerous causes of the contracture have been advanced. Due to the apparent paralysis, a nerve injury has been suspected. Others have considered obstruction to the venous outflow of blood the causative factor. Damage to the arterial circulation was mentioned by Volkmann in his original paper. The time-honored belief that pressure from tight splints caused the contracture is a legend.

It is undoubtedly true that there is some obstruction to venous outflow. There is extravasation of blood and serum. There is swelling of the soft structures, causing pressure. There certainly is an unyielding fascia and, in the light of what we now know, there is, we believe, some obstruction to the arterial circulation. This obstruction may be due either to actual arterial damage or to interruption of arterial flow from intrinsic pressure around the artery. It is probable that in certain cases a part or all of these factors combine to bring about a disintegration of the muscles from hematoma with resulting pressure and anaemia of the nerves.

Some years ago it was necessary in operating upon a patient to dissect the anterior aspect of the elbow, using novocaine anaesthesia. The brachial artery was exposed. A temporary clamp was put upon it. When the brachial artery was shut off, the patient, being conscious, immediately complained of numbness of the hand; when the temporary clamp was removed from the artery, the patient stated that there was a return of sensation in the hand. In order to confirm this observation, the clamp was again applied and at once the anaesthesia returned. From this observation, it is clear that anaesthesia follows immediately upon cessation of arterial supply. Similar observations were made during the War, following gunshot wounds of the axilla, in which the brachial artery was injured without injury to the brachial plexus. Loss of sensation of the arm and hand and later contracture were noted.

Case A. J. A. A school girl in the fourth grade, was seen October 8, 1926. She was brought down to Boston from Nova Scotia for treatment of a "claw-hand". The history obtained was that the previous spring the patient had fallen on her left arm, breaking the lower end of the shaft of the humerus. The arm had been put in a splint. Before the arm had entirely healed, the patient developed typhoid fever. The double illness kept the patient in bed for about three months. When the splint was removed from her arm, it was discovered that her arm was fixed at the elbow at an angle of about 150 to 160 degrees, and her wrist was fixed in a few degrees of extension. Since that time her hand had become stiff and useless, and there had been a marked diminution of sensation.

General examination was negative. Examination of the left elbow showed that it was held in a fixed, flexed position at an angle of about 150 degrees. The wrist was fixed in slight dorsal flexion. The fingers were extended at the metacarpal phalangeal joints and sharply flexed at the interphalangeal joints. In other words, she had a "claw-

hand". Sensory examination showed an anaesthesia corresponding with the ulnar area and a diminution in superficial sensation over the remainder of the hand. Electrical reactions over the forearm and hand were absent, except for slight action of the extensors of the fingers. The diagnosis was ischaemic paralysis,—Volkmann's contracture.

Of course we can only surmise what took place in Nova Scotia in this case. But, in the light of what we now know, we feel that there was some obstruction to the arterial circulation either in the form of direct damage to the brachial artery or pressure upon it from oedema and swelling of the tissues, with the resulting Volkmann's contracture.

On June 18, 1929, the patient was again brought down from Nova Scotia for examination. There was a distinct return of function from all of the sensory disturbances. There was still a flexor deformity of the hand, and no considerable amount of power in the muscles of the back of the forearm. She was seen by a nerve consultant who advised an electric-battery treatment. The battery was obtained, and the patient returned to Nova Scotia to continue the baking, massage, and exercises.

On January 20, 1930, she again came to Boston for observation. The condition was very much improved. The elbow extended to 115 degrees. The left wrist showed flexion to 45 degrees; pronation of the lower arm was normal; supination was 90 degrees. She was able to extend the terminal phalanx of the left thumb; there was a distinct adductor muscle; and she could adduct the thumb. Sensation was normal except for slight impairment of the tip of the ring and middle fingers.

Case R. H., four years of age. On October 19, 1924, he fell on a pile of rocks, striking his left elbow. There was no great pain at the time, but, before he arrived home, there was pain and swelling of the elbow. He was taken immediately to the hospital and roentgenograms were taken. At that time the hand was pale, cold, and anaesthetic. There was no radial pulse. There was marked tension, swelling, and ecchymosis in the region of the elbow. X-rays showed a supracondylar fracture of the humerus. The boy was immediately given ether and the fracture was reduced. A posterior plaster-of-Paris shell was applied and the arm was elevated on a pillow. There was still no radial pulse. The hand remained cold and anaesthetic, and pain in the elbow increased in severity. Voluntary motion of any of the digits except the thumb was not possible.

The following days the situation did not change. On October 24, 1924, a neurologist described the condition as: "Loss of sensation over the little, ring, and tips of the first, index, and mid fingers". The patient remained in bed with the arm elevated on a pillow in the posterior plaster shell, and on November 5, 1924, sixteen days after injury, the radial pulse returned. He was discharged from the hospital to have baking and massage in the Out-Patient Department. On May 25, 1925, he presented himself with a definite "claw-hand". There was flexion of the wrist and fingers. The boy was readmitted to the hospital, and a banjo splint applied. He was discharged in September, 1925, with fingers and wrist completely extended. He has been followed since that time and now, although he describes a sensation of tightness in the hand, has a good grasp and a useful hand.

Here there is a patient who came into the hospital immediately following injury with a supracondylar fracture of the left humerus, a painful swollen elbow, a cold anaesthetic hand, and absent radial pulse. He received what, at that time, constituted adequate treatment. Under the fluoroscope the fracture was reduced, and, because of the still absent radial pulse, the arm was placed in the position of elevation on a pillow, and diligently watched. Observation continued for sixteen days. At last, the radial pulse returned; but the patient developed Volkmann's contracture.

The significance of the continued cold, anaesthetic hand, with absent radial pulse and pain in the elbow increasing in severity as the hours passed, in the face of a reduced fracture, was not appreciated. While waiting, the damage was done, not throughout the sixteen days before the pulse returned, but probably during the first twenty-four hours, certainly early.

CASE W. A child of seven was brought to the hospital thirteen days after receiving a supracondylar fracture. There was swelling and hematoma of the elbow. The arm was kept elevated on a pillow for one week, when an open reduction was performed. A satisfactory reduction was obtained, but a Volkmann's contracture developed.

It was apparent that our treatment of certain cases of supracondylar fracture, presenting a painful elbow, an absent radial pulse, with a cold anaesthetic hand after reduction, was not adequate to prevent the development of Volkmann's contracture. We believed some interruption of arterial circulation was the cause. It was agreed that we would operate upon the next case showing the symptoms described above.

And—

On August 21, 1926, such a case presented itself.

CASE M. T. A boy, five years of age, was brought to the hospital with a left supracondylar fracture following an injury six hours before admission. There was some ecchymosis of the soft parts, no radial pulse at the left wrist, and no evidence of nerve injury. X-ray showed posterior displacement of the distal fragment of the humerus. The fracture was manipulated under the fluoroscope, and a satisfactory reduction obtained. But the radial pulse at the wrist was still absent. The patient was immediately operated upon, the operation being a fasciotomy. The brachial artery was found hooked over the end of the proximal fragment. It was released, and the radial pulse returned at once. Part of the reduction was lost during the operation, necessitating a second manipulation five days later. No Volkmann's contracture developed, and the patient was discharged from the hospital twenty-two days after admission. On October 19, 1927, the case was reviewed for an end-result examination and was given a perfect rating. The hand and elbow motions were excellent.

The operation of fasciotomy is performed as follows: An incision is made on the flexor aspect at the elbow, just medial to the biceps tendon. The fascia is opened widely. In certain cases the bicipital fascia will be found to be under great tension, exerting tremendous pressure upon the brachial artery which passes beneath it. This fascia is also incised. The brachial artery may be observed to ascertain the presence or absence of injury to the vessel. The fascia is left open, the skin being loosely sutured. A posterior molded plaster splint is applied and the arm is elevated upon a pillow.

During the incising of the fascia, the reduction of the fracture is often lost. Acute flexion of the elbow, which is necessary to maintain satisfactory alignment, would further embarrass the circulation. The arm is left in the extended position. The fracture, in these cases, is of secondary importance, and further reduction is postponed until such time as the circulatory disturbance has been eliminated.

CASE A. DE G. On August 8, 1933, a boy, seven years of age, fell five feet from a fence, injuring the left arm. He was admitted to the hospital two hours after injury. X-ray showed a supracondylar fracture of the left humerus with backward and lateral displacement of the distal fragment. There was no radial pulse. Under the fluoroscope, reduction was obtained. There was a question of a faint radial pulse. He was put to bed with the arm, elevated on a pillow, in plaster anteroposterior splints. The following morning (twelve hours after manipulation), there was no radial pulse. The extremity was cold and anaesthetic. Pain in the elbow had gradually increased. A fasciotomy was performed at once, and it was found that the brachial artery had been caught in the fracture. The artery was released. There was evidence of hemorrhage in the region of the radial head; and investigation of this area showed a tear in the radial artery. This tear was closed with an atraumatic arterial suture. The fascia was left open, the skin closed, and the arm elevated upon a pillow. The day following operation, the pain had ceased, the hand was warm, and sensation was increasing. Four days after operation, the radial pulse had returned. August 21, 1933, open reduction was performed to reduce the fracture, the original reduction having been lost at the time of the fasciotomy. The arm was kept in acute flexion for three weeks. No Volkmann's contracture developed in this case.

CASE A. H. October 20, 1933, a boy of nine years of age was admitted to the hospital. An hour before admission, he had fallen on his left arm. X-ray showed a typical supracondylar fracture with marked displacement of the distal fragment. There was pain in the elbow; the hand was cold and anaesthetic; and there was no radial pulse. The fracture was reduced under the fluoroscope; the radial pulse was still absent. Four hours after reduction, there was no radial pulse, the hand had become slate-colored, and was cold and anaesthetic. Pain in the elbow had increased with each hour, as had the swelling of the arm. An operation of fasciotomy was performed, and a thrombosis of the brachial artery was found, opposite the site of the fracture. There was pulsation above the thrombosis, but none below. The arm was placed on a pillow, and the radial pulse returned four days later, the warmth and color having improved the day following the operation. October 25, 1933, the fracture was reduced by manipulation, and October 31 the patient was discharged from the hospital. No Volkmann's contracture developed.

CASE W. B. A boy, five years of age, fell to the ground while playing on a trapeze. There was pain in the left elbow. He was seen at once by a local physician who took the boy to the hospital. At the hospital, one-half hour after injury, the hand was white and anaesthetic and there was no radial pulse. There was considerable swelling of the arm in the region of the elbow, but no motor-nerve involvement. X-ray showed a supracondylar fracture with marked displacement. Following reduction under the fluoroscope, there was no radial pulse. Fasciotomy was performed at once. The brachial artery was found caught over the end of the proximal fragment. The medial nerve was also over the end of bone, but stretched less than the artery. These structures were released. A posterior plaster mold was applied, and the arm was elevated on a pillow. The radial pulse returned in five days. One year later, the fracture was rated as a good result and no Volkmann's contracture had occurred.

CASE C. R. A girl, seven years of age, was admitted to the hospital several days after receiving a supracondylar fracture. Three attempts at reduction had been made. The radial pulse was present. Reduction under the fluoroscope was obtained. The following morning there was no radial pulse, and there was an ulnar and radial palsy. The case was watched for a few hours. As there was no improvement, a fasciotomy was performed. The artery was not caught in the fracture, and the radial pulse soon returned. Apparently pressure within the fascia had been sufficient to interrupt the arterial circulation. No Volkmann's contracture developed.

Case R. P. April 27, 1933, a boy was brought to the hospital immediately following an injury to his left elbow. He stated that, while attempting to pull a root out of the ground, the root suddenly gave way and he fell backward, his left elbow striking on a stone. Interpretation of the roentgenographic examination was as follows: "A roentgenogram of the left elbow shows a complete transverse fracture through the lower third of the shaft of the humerus, approximately three centimeters above the elbow joint. The distal fragment is displaced about four centimeters posteriorly and upward".

On examination the boy showed a marked swelling about the elbow joint, with marked deformity. No radial pulse could be obtained. The hand was cold and white. The elbow was manipulated into excellent position, but the radial pulse could not be obtained in any degree of flexion or extension of the arm. Immediate operation was indicated. An incision was made along the medial aspect of the lower third of the upper arm, and the brachial artery was picked up about midway in the arm. It was then followed down to the fracture site where it was found that the artery had been completely severed. Both ends of the artery were contracted and bleeding had stopped. The ends of the severed artery were tied. The fragments of the fracture were again placed in apposition. It was obvious that the injury to the artery had been made by the upper fragment which had penetrated the lower third of the biceps muscle. The skin was closed and the arm placed in a posterior molded plaster, in extension, to favor the collateral circulation. Postoperative x-rays showed the position and alignment of fragments to be good.

The hand remained cold and white for twenty-four hours. At the end of that time, there was perceptible warmth about the hand and fingers. This gradually improved for three weeks, when a faint pulsation could be felt in the radial artery at the wrist.

This case demonstrates that, with the brachial artery completely severed, the collateral circulation of the lower arm and elbow is adequate to prevent gangrene and to nourish the flexor group of muscles, provided their collateral circulation is given an opportunity to function. This opportunity is furnished by release of pressure upon the circulation by the fasciotomy. There has not been any atrophy of the flexor group of muscles with degeneration and fibrosis in this case.

SUMMARY

Certain elbow injuries, notably supracondylar fractures, present themselves with a painful swollen elbow, an absent radial pulse, and a cold anaesthetic hand. If, after careful reduction, there is still diminished or absent radial pulse with loss of sensation of the hand, loss of voluntary motor power, and pain in the elbow increasing hour by hour, Volkmann's contracture is impending. Immediate operation is necessary. The operation should be a fasciotomy. Appreciation of these facts is important, not only in saving function, but also in lightening the burden of medicolegal responsibility that falls upon the doctors who treat these patients.

CONCLUSIONS

1. Volkmann's contracture does occur in the absence of splints or tight bandages.
2. Volkmann's contracture is caused in certain cases by interruption of arterial circulation.
3. This interruption may be due to direct injury to the artery itself.

4. This interruption may be due to intrinsic pressure upon the artery caused by hemorrhage within the fascial envelope.

5. The collateral circulation is sufficient if given an opportunity to function.

6. The operation of fasciotomy, performed early, gives this opportunity.

7. Since following the procedure outlined above in treating this type of injury, we have not had a case of Volkmann's contracture develop on the Fracture Service of the Massachusetts General Hospital.

The conclusions reached in this paper are further confirmed by the cases reported in the two papers which follow (page 656 and page 659).

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ISCHAEMIC PARALYSIS FROM PRESSURE OF HEMATOMA

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The following case report is of special interest in connection with the preceding paper on Volkmann's Contracture by Dr. Jones (page 649).

The patient, a school boy, fifteen years old, white, one hour before admission to the Boston City Hospital on January 2, 1935, at about eight o'clock in the evening, was coasting down the street on a sled. He remembered seeing the lights of a small delivery truck approaching and crashed into it, then became unconscious and awoke half an hour later in a police ambulance on the way to the Boston City Hospital. He did not vomit at any time after the accident.

Previous to the injury the patient had been in excellent health.

Physical examination at time of admission showed a well developed and well nourished boy, conscious and rational. There was a deep transverse laceration twelve

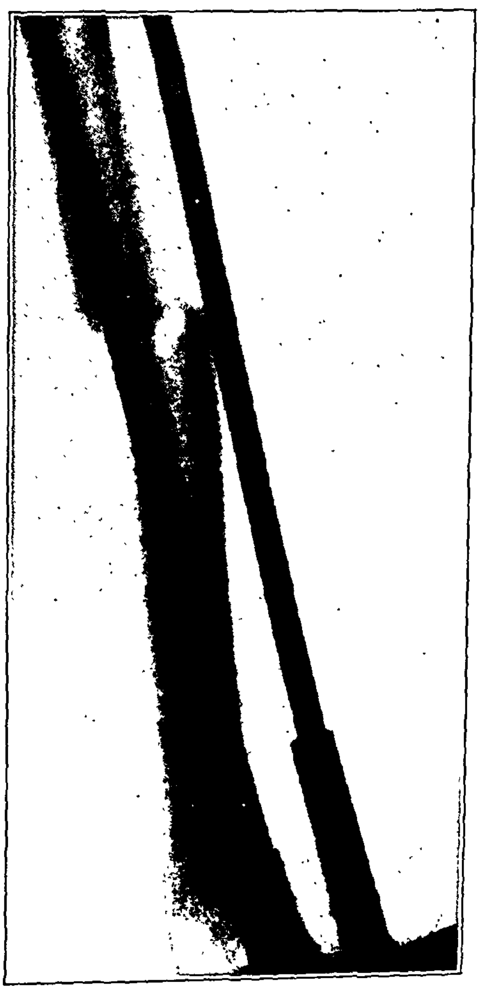

FIG. 1-A

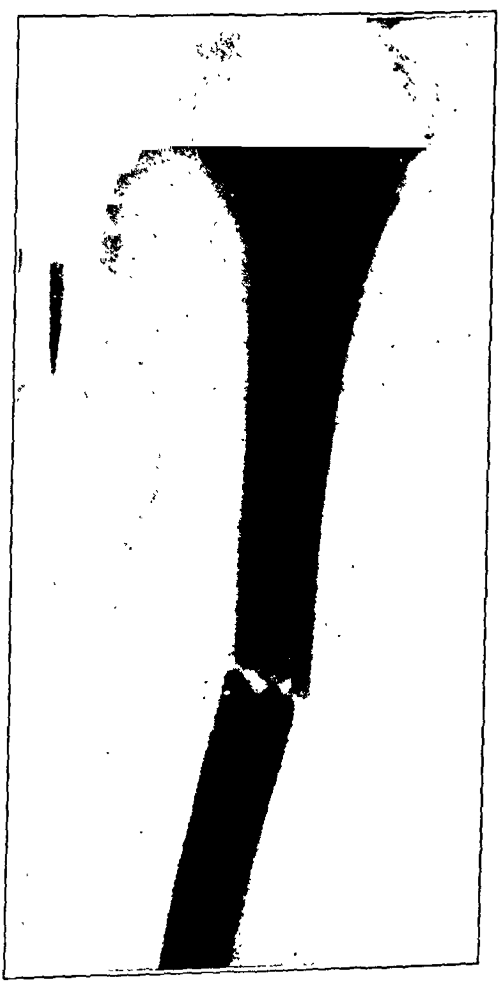

FIG. 1-B

Roentgenograms taken January 3, 1935, the day after admission.

centimeters in length across the top of his scalp. The skin edges were much avulsed and bleeding profusely. There were small superficial contusions of the left thigh and right wrist.

The left upper arm showed localized tenderness, abnormal mobility, and slight angulation deformity over the mid-shaft of the left humerus. There was a very tender, swollen area, about fifteen centimeters in length, extending over the medial aspect of the left upper arm. The tenderness extended completely around the arm, but the swelling was chiefly over its medial aspect. The left hand was pale and cold, and the nails were cyanotic. Radial and ulnar pulses could not be felt in the left wrist. Flexion and extension of the fingers of the left hand were both very weak and the fingers could be spread hardly at all. When tested by pin pricks, there was diminished sensation over the radial distribution of the dorsum of the left hand and fingers.

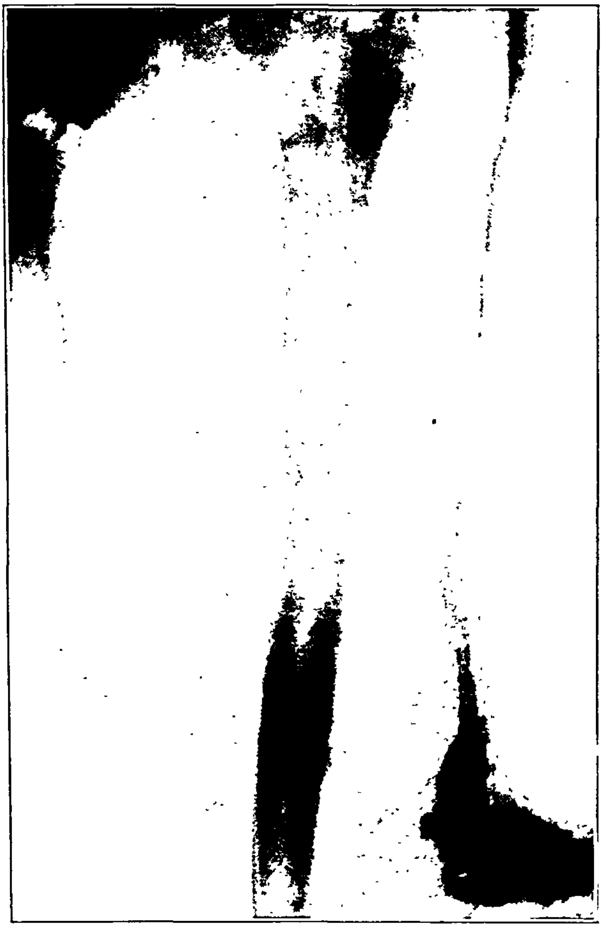

FIG. 2

Roentgenogram taken January 25, 1935.

Pupils were equal and reacted to light. Knee jerks and ankle jerks were present and normal, and there was no ankle clonus or Babinski reflex.

The patient was treated for moderate shock. Immediate x-ray showed a simple transverse fracture of the mid-shaft of the left humerus.

Under ether anaesthesia, a vertical incision, about twelve centimeters in length, was made over the medial aspect of the left upper arm. A large tense area of traumatized muscle and clot was found beneath the deep fascia. The median and ulnar nerves were identified and the brachial artery was freed up for a distance of about ten centimeters. The radial and ulnar pulses returned immediately after the brachial artery had been freed. The pressure of the hematoma caused by the fracture had evidently obliterated the lumen of the brachial artery.

Shortly after operation started, the pulse rate rose to 140 per minute. It was, therefore, considered inadvisable to take additional time then to plate the humerus or to attempt to inspect the radial nerve. The arm wound was closed very loosely with skin sutures only, and the arm was put up in loose traction in a Thomas arm splint. The scalp wound was cleansed and sutured at the same time.

The patient was kept in shock position for twelve hours. His wounds healed rapidly without infection. The next morning his left hand was warm and pink with good wrist pulses. Postoperative roentgenograms showed the bone ends in good position (Figs. 1-A and 1-B). All sutures were removed on the eighth day after operation and the arm wound strapped with adhesive. Sensory and motor nerve lesions improved slowly.

Eighteen days after operation, roentgenograms showed good callus formation, and the arm was put up in an "airplane" plaster cast with shoulder in right-angle abduction and elbow in right-angle flexion. After application of the cast, x-rays again showed good position of the fragments (Fig. 2).

Thirty-two days after injury, the patient was discharged to his home with the arm in the plaster cast.

He was seen again six weeks after injury and the cast was removed at that time. Sensation and motion of the left hand were then almost completely normal.

ISCHAEMIC PARALYSIS OF LEG SIMULATING VOLKMANN'S CONTRACTURE

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The following two cases are of interest in relation to the cases reported in the foregoing paper on Volkmann's Contracture (page 649).

CASE J. R. A man forty-five years of age entered the hospital December 6, 1931, having received a severe contusion of the right leg in the popliteal region by being crushed between the bumper of an automobile and the landing ledge of a building. There was considerable swelling and ecchymosis in the popliteal region. No pulsations were palpable below the femoral pulse in the groin. There was anaesthesia of the foot and lower leg. There was pain in the traumatized area. The right foot felt cold in contrast to the left. All pulsations were present on the left. X-ray was negative for fracture.

The foot was elevated on a pillow with a cradle and light over it. During the first week, the color of the foot and lower leg was poor. December 15, the tips of the toes were discolored and by December 25 there was dry gangrene of the toes of the right foot. The circulation of the lower leg and foot had improved little, if any. He was discharged from the hospital January 29, 1932.

The patient was not seen again until November 27, 1932. During the interval the gangrenous toes had amputated themselves. The foot was in rigid equinus. There was marked atrophy of all muscles below the knee so that the lower leg and foot looked mummified. There was no palpable circulation. The foot and lower leg were dusky in color; the temperature less than that of the left. Sensation had returned in the foot.

November 28, 1932, tenotomy was performed on the tendo achillis, in order to bring the foot into a position compatible with walking. Dependency and activity of the leg were slowly prolonged until finally, after a period of disability of two years, the patient was able to return to his work as driver of a light laundry truck. There is still no palpable circulation below the groin, the appearance of the leg has changed but little, and it is problematical how long this man will be free from circulatory difficulty.

CASE H. B. A man, forty-five years of age, entered the hospital March 12, 1935, having received a severe contusion of the left popliteal region by being crushed between the bumpers of two automobiles. There was tremendous ecchymosis, pain, and swelling of the upper leg and popliteal region. No pulsations were palpable below the groin. The left foot was cold, blanched, and partly anaesthetic. (The right leg was normal.) X-ray showed a fracture of the upper end of the fibula in good position.

In view of our experience with arms under similar condition, exploration of the popliteal region was performed. The fascia was opened widely, releasing a large amount of blood clot under considerable pressure. The popliteal artery and vein were identified. Above a certain point there was pulsation in the artery; below none. Although no thrombus was evident, there may have been one or the condition was possibly only spastic. The fascia was left open, the skin being loosely closed.

In twenty-four hours, the anaesthesia of the foot was diminished; there was a definite increase in warmth; and the color of the foot was better. In forty-eight hours, the anaesthesia had entirely disappeared and there was a further improvement in color and warmth. On the fifth day after operation, pulsation in the dorsalis pedis and posterior tibial arteries was palpable. Dependency and activity have been brought along slowly and, seven weeks after injury, the patient was walking in the hospital on a foot which

appears to have adequate circulation for the activity his work on a bakery truck will require.

On June 5, 1935, he showed some oedema below the knee. Pulsation in the dorsalis pedis (from behind *forward*) was of good volume. Color and temperature of foot were normal. Sensation was normal throughout and there were no paralyses. Patient is able to walk and is incommoded only by stiffness in knee flexion, largely due to a thick scar unavoidably crossing the popliteal space.

Here we have two very similar cases. Both were men forty-five years of age. Each received a severe crushing injury to the popliteal region. The first, treated simply by elevation and rest of the leg, resulted in a two years' disability and a leg with a very questionable circulation. In the second, where a fasciotomy gave the artery a chance to open up, or the collateral circulation an opportunity to function, the patient, after seven weeks, has a leg upon which he can tolerate dependency for increasing periods of time and will in a few more weeks be able to return to his work upon a leg worthy of his confidence.

THE TREATMENT OF CONGENITAL EQUINOVARUS (CLUB-FOOT)

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This paper is not intended as a dogmatic presentation of how to cure all club feet (congenital equinovarus), but as a study of the difficulties encountered during the treatment of 152 cases which were handled in a rural area through a well organized scheme of clinic and hospital care.

It seems generally recognized now that, although the actual cause which produces a club foot in an otherwise healthy infant is unknown, the condition itself must be regarded as an incapacity, partial or complete, for normal development of all the tissues of the limb,—*i.e.*, it differs entirely from such deformities as result after accidents and inflammation, where correction is usually followed by growth along normal lines. Indeed, many malunited fractures, especially in children, exhibit spontaneous correction through the tendency of the growth-force to restore normal structure. What is so exasperating in the treatment of club-foot is that the growth-force is continuously at work undoing the labor of the orthopaedic surgeon. The influence of this factor on treatment was almost ignored in the older text-books, and the views of these authors have colored the works of later writers. In the literature we commonly find the implication that the recurrence of equinovarus, even if slight and insidious, indicates either defective initial correction or lack of continuity and thoroughness in the after-care. These are difficult charges to meet, but the present writer's experience shows that patients who had appeared to have excellent overcorrection for months, or even years, and who also had had the most thorough supervision possible in a rural area, did gradually develop a recurrence of the deformity sufficiently serious to warrant open operation. In some cases more than one operation was necessary.

It must be stated at once that rural conditions do not permit of that daily stretching of the foot by an expert, which the best authorities consider essential, so that one has to depend on mechanical fixation, associated with such manipulations as the patient's mother can carry out. Contrary to accepted opinion, the writer is convinced that manipulation by a keen and intelligent mother, carried out several times a day, is of great value; this is demonstrated by the higher standard of results obtained in the child whose parent does take such trouble.

Most of the older writers focussed their attention on one or another structure in the limb as the primary defaulter and directed their treatment to this tissue, but the modern view of the etiology demands that we

exercise our corrective forces on all the tissues in every case. It is not merely a question of misshapen bones, tight ligaments, unbalanced muscles, faulty circulation, or contracted, inelastic skin, but of all these conditions at once.

Furthermore, earlier writers, who have been followed blindly by the authors of the later text-books, divided club feet into two groups: (1) those which were correctable by moderate force; and (2) those of the rigid type.

This seems to the author to suggest quite a wrong outlook on the problem; it is preferable to consider two extreme groups of club feet:

1. Those which, given favorable conditions, have an innate capacity to develop into practically normal feet, although if neglected they may result in extreme rigid deformity;

2. Those which are totally incapable of balanced growth, however favorable the conditions.

Between these two extremes exists a whole range of feet, the treatment of which will tax the patience of the surgeon in proportion to their place in the scale. This would explain why some neglected cases with rigid deformity will respond admirably to a few forcible manipulations, followed by fixation in plaster for a short period; whereas other cases, well corrected in early infancy, will provide recurrent relapses even during the course of active treatment.

A few writers like Ombredanne warn against the inevitability of such relapses, but they seem to suggest that such relapses occur in a small minority of cases. On the contrary, in the writer's experience, this minority presents such a serious problem that the treatment of such cases requires more study than it appears to have received in the past. In other words, the effect of inducing parents to bring children with club feet for treatment immediately after birth is actually to increase, not to diminish, the difficulties of the surgeon. We do not for a moment wish to imply that it is not desirable to begin treatment so early, or that the ultimate result of such early treatment is not much more satisfactory for the patient; but we would remind surgeons that it is much simpler and more dramatic to convert a neglected, grossly deformed foot into a weight-bearing one by a single wrenching, or bone-wedge, than to persevere for years with conservative measures and eventually have to persuade weary parents to allow a final correction by open operation. It is the plea of the present writer that such a late operation does not by any means represent failure of conservative measures, but that, like so many orthopaedic operations, it is one essential stage in a long, carefully planned course of treatment,—*i.e.*, conservative treatment and operative treatment of club-foot are not alternative routes, but essentially complementary measures.

In planning the course of treatment, it would be very valuable to be able to estimate from one's first inspection of the new-born foot what grade in the scale of growth-deficiency it is to occupy. The writer must confess that this seems to present great difficulties. Here again, the extremes are easier to recognize than the intermediate grades to classify.

The foot which is likely to present difficult problems in treatment for years is that type in which the heel is represented by a dimple instead of a prominence, the calf muscles feel stringy under their coat of fat, and the invertors and sole muscles offer very great resistance. In the treatment of unilateral cases, one is likely to meet very obstinate relapses if the affected limb lags behind its fellow in growth, in spite of apparent complete correction, and especially if the leg muscles fail to develop in bulk. In bilateral cases, one may get some estimate of the defective growth by comparing the bulk and elasticity of the thigh muscles with those of the lower leg, where the maximum incidence of the defect occurs.

This paper is based on a study of all the cases of club-foot treated in the Bath and Wessex Orthopaedic Hospital and its associated Clinics during a period of almost ten years. In the earlier years most of the patients had undergone some part of their treatment in other areas or by other surgeons, so that the results of quite a number of different methods have been observed. Lately it has been noted that in nearly all cases the patients have been treated within a few weeks of birth, some within a few days, and most of them have been continuously in the care of the County Orthopaedic Sisters, who were all trained at Oswestry. Almost all of the open operations have been performed by the writer in the central hospital.

In trying to rationalize the stages of treatment of such a common deformity as congenital club-foot, one ought not to insist on measures which only give a satisfactory result in the hands of a first-class surgeon; on the contrary, methods should be evolved which are curative when carried out by any surgeon of average ability. This seems to have been somewhat overlooked in the past and nearly every well known orthopaedic surgeon had some special procedure, which gave excellent results in his hands, but was condemned by numbers of others. The writer feels that the lines of treatment to be described demand merely the operative technique of the ordinary surgeon and are based on anatomical grounds, rather than on the gift of an especially sensitive judgment.

Before discussing details, a summary of the lines of treatment on which cases can conveniently be attacked is given.

1. In the first few months after birth: manual correction and fixation by strapping, plaster-of-Paris, or splints.

2. In resistant or relapsed cases and those in which the feet are rigid when first seen: forcible correction under anaesthesia at the earliest age that the infant's general condition permits.

3. In cases of recurrent relapse and in cases in which the dislocation of the astragalus cannot be reduced by manipulation: open lengthening of the tendo achillis and dissection of all tight structures until the astragalus goes fully under the tibia.

4. In cases of failure of the peronei to balance the invertors after years of conservative treatment, or where continuity of treatment is not possible: tarsal-fusion operation (Dunn's as for equinovarus of poliomyelitis).

5. In cases of persistent adduction of the axis of the corrected foot in relation to the patella (torsion): tibial osteotomy.

In regard to such a program of treatment, it is desirable to elaborate a few matters of detail, for, in dealing with this deformity, as with most orthopaedic conditions, it is on minute attention to detail that success is built.

MANUAL CORRECTION AND FIXATION

In regard to the manual correction of the feet of young infants, the opinion now seems to be unanimous that one cannot begin treatment too soon after birth; for treatment in an out-patient clinic one must wait till about the tenth day, but all sisters in maternity wards should be trained to stretch the feet from birth, each time they attend to the infant.

Another point on which there is almost unanimity of opinion is that the tight tendo achillis provides a useful fulcrum for stretching the adductors and invertors of the foot and that the varus deformity should, therefore, be overcome before very much attention is paid to the equinus. In the writer's experience the former yields rapidly—in a matter of days or weeks—although doubtless in many cases Brockman's dictum is true that only a pseudocorrection has been obtained and that the head of the astragalus has not been inserted between the internal malleolus and scaphoid, owing to the tough, inelastic calcaneo-scaphoid ligament. This is a question which is very hard to prove or disprove except by open operation later; certainly in relapsed cases this is found to be the condition.

Even more difficult is the reduction of the body of the astragalus backward into the narrowed mortise between the malleoli. The difficulty is exemplified by the variety of operations designed to secure it: (1) curetting out the bony nucleus of the astragalus to make it compressible; (2) taking a wedge out of the astragalus (possibly from the os calcis also); (3) osteotomy of the external malleolus.

All of these procedures have been condemned by other writers on the ground that they interfere seriously with growth in the foot. This also is a difficult matter to prove, because the club foot which is resistant enough to require such heroic measures is certain to have limitation of growth of all its bones in comparison with the sound limb, or even in comparison with a less severe club foot on the opposite side. This is a factor which does not seem to have been weighed by all writers on the subject.

One thing is certain,—the earlier normal alignment is secured and the more persistently it is maintained, the more nearly will the development of the foot bones approximate the normal in size as well as in shape.

In regard to the frequency of the manipulations in infants, once a week is all that is possible in rural areas; but, if this is associated with frequent, gentle stretching every few hours by the mother and, equally important, by reeducation of the weak peronei and toe extensors through tickling and pinching the skin over their insertions, then very good results are obtainable.

In our cases, after manipulation, fixation has been secured by adhesive strapping in the very young infants and by plaster-of-Paris in older ones; both methods are applied by a specially trained sister in the clinic.

In applying the strapping in very young infants we observe the precaution recommended by Elmslie,—namely, the inclusion of the knee in right-angle flexion—so as to control the "torsion" and reduce the tendency to knock knee, which may easily be aggravated by very vigorously pulling the foot into valgus. The writer does not believe that by any of these means it is possible to produce a correct relation of the axis of the foot to the patella in every case; no doubt the abnormal direction of the neck of the astragalus does not always change with manipulations and splinting.

When the foot has developed some size and shape, it is often more convenient to fix it in the corrected position in plaster-of-Paris. In the plaster also is included the flexed knee, which helps to prevent the conical limb from sliding out of the apparatus. In very small feet, it is essential to pour Heussner's glue over the back of the heel after the stockinet is applied. Otherwise, a very badly developed os calcis may become pulled up by the tendo achillis while the plaster keeps the toes up, producing a convexity of the sole downward, a deformity very hard to correct later. It is important to mark the level of the tips of the toes on the stockinet at the back with an indelible pencil, so that if even a slight degree of upward slipping occurs it is noted at once. While the plaster is setting, it must be molded well up under the front of the os calcis; this is facilitated, as the plaster begins to set, by putting on a dry crinoline bandage, according to Putti's method, in order to absorb the surface moisture and to permit molding. This bandage is removed again as soon as the plaster sets. The writer thinks it very important to stretch the tendo achillis and to apply the plaster with the patient in the prone position with the lower leg vertical while an assistant steadies the malleoli. By this method, all the dorsiflexion can be localized by the thumb on the front of the os calcis, while the fingers push the astragalus back into the mortise.

FORCIBLE MANIPULATION

It has been the writer's experience with a few relapsed or resistant cases treated within the first week of birth that, although overcorrection was obtainable by force without anaesthesia, if the foot were held even in correction a little short of the maximum, it remained dead white from tension on the arteries; if it were moderately corrected, it stayed purple from tension on the shortened veins. This condition was also noted in one severe case at open operation, where all the soft parts on the inner side were divided after careful isolation of the posterior tibial vessels. In such cases, periodic forcible manipulation under anaesthesia must be resorted to.

In many cases the manner of stretching already described, with the patient prone, allows full overcorrection of the equinus without tenotomy,

but, in a certain number of cases, only the front of the foot will come up and the ill-developed os calcis remains anchored with its axis vertical. In some of these cases, the writer has secured most satisfactory dorsiflexion after a subcutaneous division with a tenotome of the structures under the tendo achillis, special attention being paid to the posterior parts of the lateral ligaments. Sufficient attention does not seem to have been paid to the part played by the lateral ligaments in maintaining the equinus; once a certain degree of deformity is reached (as with hyperextended knuckles), the shortest course between their attachments is behind, not beside, the joint. Elmslie has referred to this tension of the posterior fasciculus of the external lateral ligament. With the subcutaneous division described there is a good deal of bleeding, but the circulation has not been dangerously interfered with. The great advantage in leaving the muscles intact is that one can put the limb up in overcorrection at once without fear of separating the tendon ends permanently.

OPEN OPERATION

In cases of irreducible dislocation of the astragalus, whether due to neglect or to severity of the original deformity, in which manual correction or forcible manipulation has not proved adequate, open operation is indicated.

Lengthening of Tendo Achillis and Dissection of Tight Structures

The open operation which the writer has found to give most satisfactory results has three features which she has not seen emphasized elsewhere: (1) dispensing with a tourniquet; (2) postero-external skin incision; (3) posterior approach to the ankle joint and division of all the layers of the deep fascia of the leg.

1. The reason for dispensing with the tourniquet is that in severe cases the veins and arteries are shortened, as well as other tissues, and when the foot is dorsiflexed and everted venous congestion or anaemia develops, either of which jeopardizes the healing of the wound. The inevitable disturbance of a tourniquet may just tip the scales adversely.

In one very difficult case in the author's series, when all the obstacles to reduction of the dislocation of the astragalus had been removed, only the neurovascular bundle remained at the back of the limb, and the circulation of the foot was good as long as the foot was held at 100 degrees with the leg, but, as soon as it was brought to 90 degrees, pulsation ceased in the posterior tibial artery and the toes became dead white. In view of this, the limb was fixed by a sling of adhesive strapping only (no circular turns) instead of plaster-of-Paris, and healing and maintenance of the circulation were good. This fundamental difficulty with the circulation, apart from ill-adjusted apparatus, does not seem to have been stressed enough by writers.

2. The skin incision is made on the outer side of the tendo achillis, because after the correction the skin behind the internal malleolus is so

tense in severe cases that, if it has already been traumatized with a knife and is subjected to the tension of stitches, some of it is sure to slough. If a slight S-curve is given to the cut, retraction of the flap directly across to the tibial vessels is possible without strain. This procedure permits very good exposure of the external annular ligament and the posterior fasciculus of the external lateral ligament, which help to maintain the equinus, as noted by some previous writers. These ligaments should be divided. Although the peronei then seem to lie more comfortably in front of the external malleolus and to evert the foot better in this position, the temptation to leave them there should be resisted, as the skin is thin over them.

3. After the short tendo achillis has been split Z-fashion and before it is sutured, a posterior approach is made to the ankle and the subastragaloid joints. The reason for this is that in severe cases the writer has found it to be quite as important to replace the body of the astragalus under the tibia as to force its head between the scaphoid and internal malleolus. Only a few writers have emphasized this. If a true correction of the equinus is not obtained in this manner, then the reduction of the head is apt to lead to an increasing valgus deformity, just as occurs with equinus in poliomyelitis, so that, although so called "over correction" has been obtained, yet really a varus deformity has only been converted into a severe valgus deformity. The writer has under treatment at the present time a man of thirty who is now incapacitated for work because of severe foot strain. In infancy, his congenital club feet were converted into severe flat feet, causing the present foot strain. The valgus cannot now be corrected by manipulation or by dealing with the double slight equinus.

In every one of the serious cases in which this operation was employed, it was noted that division of the tendo achillis gave no improvement of the equinus and that division of the posterior ligaments of the ankle and subastragaloid joints gave little more, until the lateral ligaments had been cut. Even then, complete dorsiflexion was not possible and usually it was necessary to dissect and divide the fascia over the flexor hallucis longus and the tibialis posticus, and the more superficial layer of deep fascia over the posterior tibial vessels, including the internal annular ligament. After this procedure, final correction of such varus as remained was overcome by passing a sharp periosteal elevator along the inner side of the os calcis, astragalus, and scaphoid close to the bone, in order to avoid the main vessels. The tendo achillis was sutured with No. 60 linen thread; a continuous buried suture was employed, with the foot held at a right angle and the knee slightly flexed. This position was maintained by a plaster gutter so that the necessary tone might be kept in the sutured muscle and the ligaments around the ankle could reunite in the corrected attitude. It is to be noted that the cases of severe equinus, such as those seen in poliomyelitis, are associated with weakness and fibrosis of the calf muscles, so that after a muscle has been lengthened one cannot expect it to have normal strength. Such weakness is masked in the equinus po-

sition. The writer has had no case in which the patient could not walk on tiptoe after the operation, but in only a few cases could the patient balance on the one foot on tiptoe unsupported for more than a second. It is important to realize this; if not, the operator may be blamed for lack of skill.

Furthermore, in these severe cases, when the foot is brought at a right angle with the leg and directly back under it,—when the anterior dislocation has been reduced—then the bones are found to be incongruous,—the tibia rocks unsteadily on the astragalus. This is one argument for performing the operation when the patient is young, as the soft bones of early childhood seem to adjust quickly and this tendency is not noticeable long. It is difficult not to injure the surface of some of the bones during the dissection, as they are soft and the abnormal ligaments are very tough and fibrous, but in the writer's cases troublesome stiffness of the joints has not resulted. Naturally, the abnormal shape is likely to limit motion to below the normal range.

A final word may be said in regard to the scope of the operation,—it must be regarded as one stage in a long course of treatment, not as in itself a sudden "cure". The result depends not merely on the difficulties actually encountered—such as incongruity of bones and shortening of vessels and nerves—but most of all on the ultimate capacity of the limb to develop balance in its muscles, for the bones are but the handmaidens of the muscles. (We know how insidiously deformity develops after poliomyelitis, and this parallel seems to have been overlooked in much of the writing about club-foot, where relapse has nearly always been attributed to "incomplete correction".) As in cases of poliomyelitis, deformity will always recur in the club foot with unbalanced muscles until an arthrodesis of most of the tarsal joints has been done. The ideal age for this arthrodesis is still a matter of dispute. The writer has found that, with the utilization of Putti's device—an inner leather boot, molded on a corrected cast of the foot—these tarsal fusions can be done successfully, in cases of club-foot and poliomyelitis, in quite young children. The soft bones, however, must be adequately protected for years.

It is not only the peronei which lack power in cases of club-foot, but in some instances the dorsiflexors are affected, either with the peronei, or alone. When the dorsiflexors are involved, there is a troublesome dropping of the front of the foot at each step, which ultimately results in a fixed cavus deformity at the mid-tarsal joints. This condition also is an indication for arthrodesis.

Tarsal Arthrodesis

In severe and neglected cases, some form of operation on the bone is indicated. The writer has used the Dunn type of double arthrodesis (subastragaloid and mid-tarsal with removal of the scaphoid) for those cases in which the muscle balance is persistently faulty or in which there is severe bone deformity, due to neglect. In a few cases of the latter type

the feet have already become so rigid that the removal of a bone wedge, disregarding joints, gives stable correction. Fortunately, such cases are rare in these days of early diagnosis and thorough after-care. The writer feels strongly that, even if the Dunn operation has ultimately to be resorted to in any case, yet none of the conservative treatment and tendon-lengthening operations ought to be considered as wasted, because the foot will have grown on normal lines and very little bone destruction will be needed when the operation is performed to correct faulty balance instead of bone deformity.

The technique of the tarsal arthrodesis has now become so standardized that no details need be given. In only one respect would the writer suggest a modification in this technique which, although it may be used by others, has not been given publicity by surgeons,—namely, in regard to the incision. It seems an almost universal practice to curve this backward behind the external malleolus, which means that a thin flap of skin has to be dissected and retracted far inward in order to give access to the scaphoid and inner joints. Many surgeons have found that this flap has poor vitality and, if a great thickness of wool is applied under the plaster to protect it, then one has difficulty in molding the plaster to control the tarsal bones. The writer has found it useful, however, to begin the incision over the front of the fibula, about two inches above the ankle joint, carry it down along the outer edge of the extensor tendons until the astragalo-cuboid junction is reached, and then sweep it outward and backward to the base of the fifth metatarsal; thus, the curve is convex inward and not outward as in the earliest incision of Dunn. A small flap of skin is dissected backward to expose the peronei, so that they may be freed from their sheathes and retracted. No retraction is necessary in dealing with the inner tarsal bones and joints; the devitalizing effect of a metal retractor is, therefore, avoided, and less skilled assistance is required at the operation.

Astragalectomy

Astragalectomy has been given by some writers a wide indication in the treatment of club-foot; by others it has been utterly condemned. As with many other controversial questions, truth lies somewhere between.

The old neglected case of club-foot with ankylosis of the ankle in an unfavorable position seems to the writer best dealt with by astragalectomy.

Tibial Osteotomy

Osteotomy of the tibia has been found useful by the writer in a limited number of cases. It is often said that the inward deviation of the long axis of the foot is only apparent and can be corrected by replacing the astragalus properly; however, in the foot of a child of over seven, if the neck of the astragalus is set at an abnormal angle, the front of the foot is bound to lie in a faulty direction in spite of the fact that the scaphoid may be carried into correct relation with the head. Though the distor-

tion is seldom in the tibia itself, by far the simplest way of dealing with it is to divide the tibia in its lower third, where it is most circular, and rotate the lower fragment outward until the axis of the foot bears a normal relation to the patella. In many cases, where there was a tendency to relapse, permanent correction resulted after this simple measure.

After-Care

The after-care in these open operations should vary with each case. Where muscle balance is nearly normal, after correction of the structural defect, mere outside wedging of the sole and heel may suffice. In bilateral cases, it is always useful to have the patient wear the left boot on the right foot and vice-versa, which is quite the simplest way of controlling that adduction of the great toe which is normal in very young children, but which represents the first stage toward relapse in cases of club-foot. If the peronei and dorsiflexors are weak, the leather mold inside the boot is often enough support. If not, an inside iron and outside T-strap are indicated. Usually in cases of severe club-foot the knee is knocked and the axis of the foot deflected inward in relation to it. This condition demands control by calipers and the socket is put obliquely in the boot to turn the foot out.

There are two rarer types of congenital varus—absence of the tibia and metatarsus varus—but they will not be discussed in this presentation.

SUMMARY

While early diagnosis and persistent treatment of congenital foot deformities improve the ultimate function and appearance of the limb, they by no means reduce the difficulties of the surgeon, and open operation must often play a part in the course of the most carefully directed and most conservative treatment. The writer suggests that in the case of a severe club foot a careful dissection along anatomical lines will enable the bones to develop more completely and normally thereafter, so that this measure must not be condemned offhand as a "mutilating procedure" like the bone wedges that have to be removed in old neglected cases. On the other hand, such an operation does not exclude the need for prolonged conservative treatment following it,—that is, it has not the final and dramatic effects of correction of a thoroughly deformed case which has reached a stationary stage.

TREATMENT OF CONGENITAL SCOLIOSIS DUE TO A HEMIVERTEBRA *

BY LEO MAYER, M.D., NEW YORK, N. Y.

Recently, two articles have appeared dealing with the operative treatment of congenital scoliosis due to hemivertebrae. In one[1], the authors begin: "The impossibility of correcting by ordinary methods lateral curvatures caused by hemivertebrae led to the attempt in July, 1924, to remove the anomalous wedge-shaped body and its arch." Of ten patients operated upon—five with curvatures caused by hemivertebrae and five with ordinary scoliosis—the authors report that one died of shock, three were markedly improved, two were improved with respect to lateral curvature but developed a kyphos, and four received no correction at all. The authors conclude: "Removal of the body and posterior arch of a hemivertebra is feasible in the lumbar region of the spine and is the only means of correcting a lateral curvature caused by this anomaly."

In the other paper[2], stress is also laid on the impossibility of correction by non-operative measures of scoliosis due to hemivertebrae and this opinion is given as the logical justification for operative removal of the anomalous bone. Although two successful results are reported, the operative risk looms unnecessarily high when one is faced by the fact that scoliosis due to a hemivertebra—particularly one situated in the lumbar region—can, in young children, be successfully treated by a simple non-operative procedure devoid of all operative risk. This contention, so strikingly at variance with the opinions expressed in the two papers mentioned, the author wishes to substantiate by the report of four cases,—three observed for periods of four to nine years, the fourth at present still under treatment. The method thus far has been used only in children under two and one-half years, but the writer can see no reason why it is not applicable to older children, provided the scoliosis has not become rigid.

An infant with a hemivertebra usually shows enough external abnormality to attract the mother's attention (Fig. 1). As a rule, the body is held in lateral flexion,—the head and shoulders are inclined away from the side of the hemivertebra. This position is fixed. Attempts of the mother to correct it make the baby cry and are, therefore, not kept up. One of the author's patients, however, did not show this lateral flexion. She was brought for examination because of a disparity in the length of the legs, which had been diagnosed as a congenital dislocation of the hip. Examination, however, proved the shortening to be due to a fixed obliquity of the pelvis, caused by a sharp lumbar scoliosis which had been induced by a hemivertebra.

Despite the fixed nature of the curve, some flexibility has been present

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, New York, N. Y., January 14, 1935.

Fig. 1

Case 4. A.K., aged four months. Photograph illustrating the right total convex scoliosis and the pelvic obliquity.

in the four cases studied. The surgeon's first task, after the accurate determination of the level of the hemivertebra, is to test the degree of possible correction. This is performed with the aid of an assistant who exerts

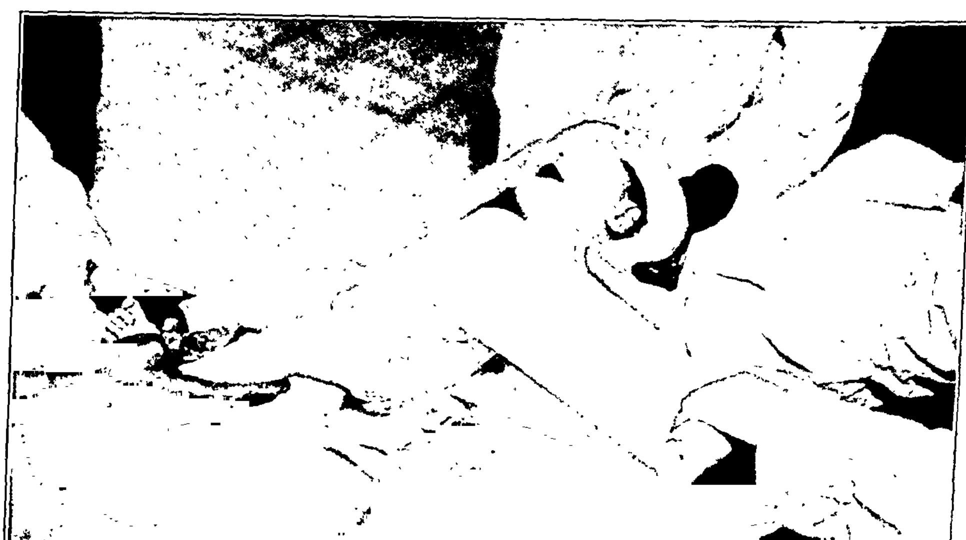

Fig. 2

Photograph illustrating the routine method of applying plaster to correct the right total scoliosis.

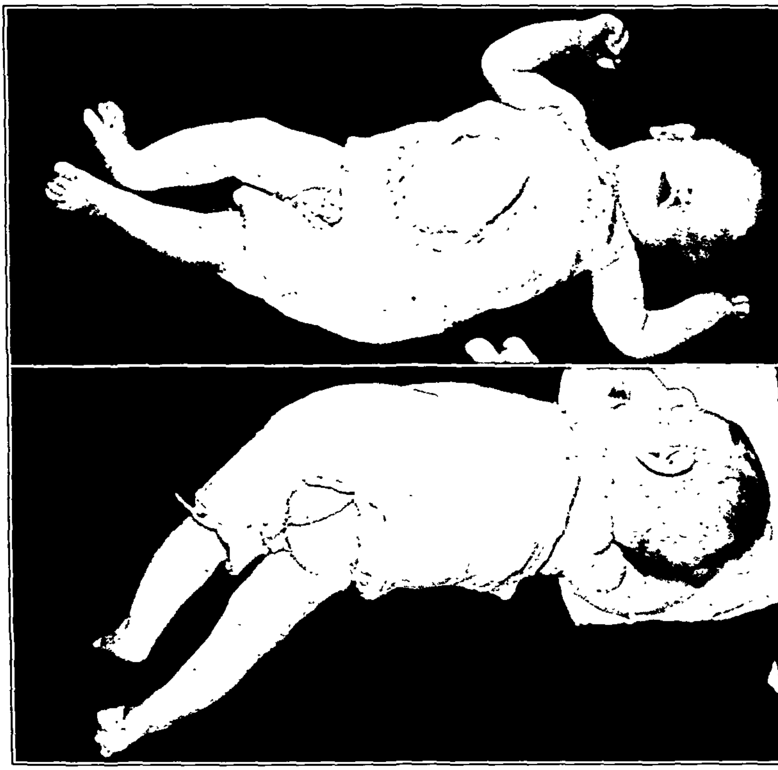

Fig. 3

Case 4. A.K., after application of plaster-of-Paris corrective spica. The right convex curve has been converted into a left convex curve. The elevated left side of the pelvis has been brought to a lower level than the right side.

Fig. 4

Photograph illustrating the modified method of applying the plaster. A spica is first applied to the left hip, holding the limb in abduction. When the plaster has hardened, the head and shoulders are swung toward the right, the left side of the pelvis is depressed, strong traction is made against the convexity of the curve by the muslin bandage, and the plaster corset is then completed.

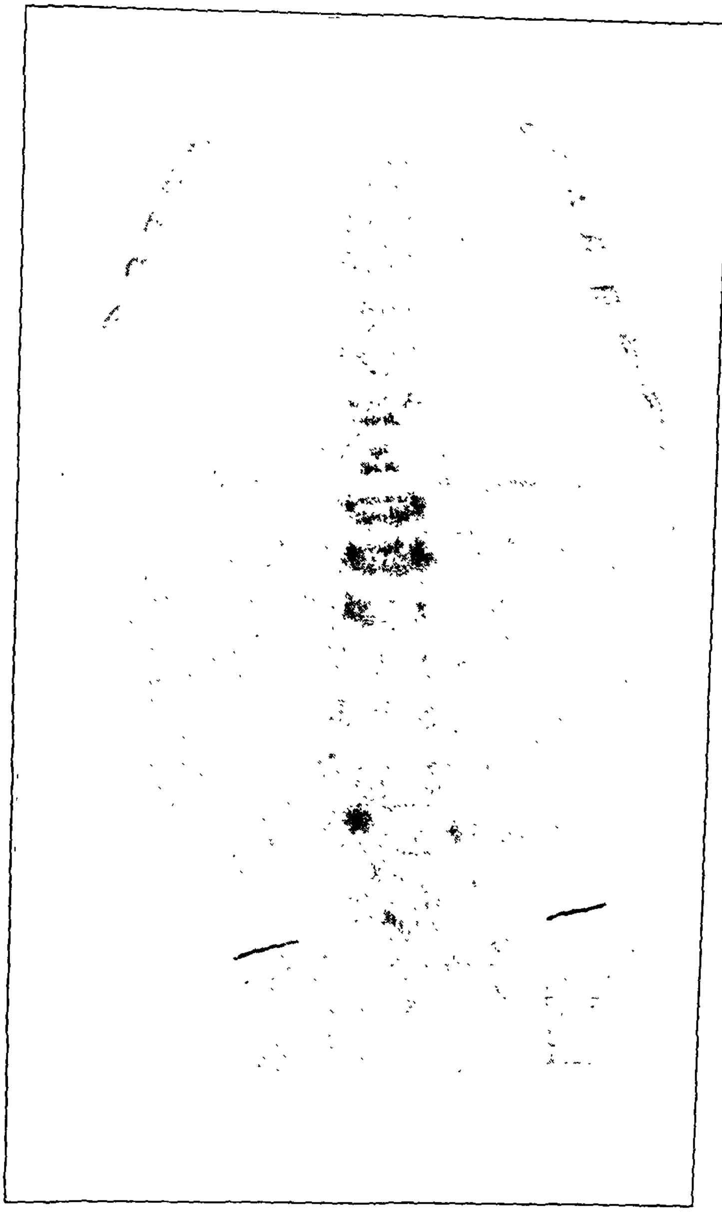

FIG. 5
Case 4. A.K., before treatment was begun. Note the hemivertebra situated between the first and second lumbar vertebrae, causing an angular deflection of the spine of approximately 20 degrees.

a steady pressure against the convexity of the spine in the region of the hemivertebra while the surgeon gently swings the pelvis and shoulders in the opposite direction, in the attempt to change the convexity into a concavity. If a roentgenogram during this manoeuver confirms the impression that some correction has been accomplished, the prognosis for a cure is excellent.

Treatment should begin as soon as the diagnosis has been made. Unlike the operative therapy, which, according to its advocates, should be postponed until the child is two years or older, the non-operative treatment may be carried out in early infancy; in fact, the earlier the better.

The method is eminently simple. The child is placed on a small hip rest. The skin of the abdomen, back, and thighs is covered with a layer of zinc salve or desitin salve to prevent excoriation by urine and faeces. Two thicknesses of sheet-wadding are then applied from the axillae to the knees. A pad of heavy felt, approximately six inches square, is placed over the apex of the spinal convexity in the region of the hemivertebra. A six-inch muslin bandage is slung about the patient's body and the two free ends are wound over a stick to prevent wrinkling. Gentle traction is then made by an assistant, thus holding the felt firmly against the convexity of the spine (Fig. 2). Two smaller felt pads are now placed on the iliac crest and beneath the axilla of the concave side.

These are best fastened in place with a crêpe-paper bandage. The operator now gently corrects the curvature by swinging the shoulder and pelvis of the concave side in the direction opposite to the traction exerted by the assistant's pulling on the muslin bandage. After a few minutes of steady pressure and when definite correction has been noted, plaster-of-Paris is applied from the axilla to the knees with the spine in maximum correction (Fig. 3).

Fig. 6

Case 4. A.K., after one year of treatment. Note the correction of the pelvic tilt and the good alignment of the vertebra, despite the persistence of the hemivertebra.

As is to be expected, the infants are uncomfortable for a few days. Their discomfort can be lessened by trimming the plaster generously so as to allow maximum room for respiration and digestion without, however, diminishing the amount of correction. The head of the bed should be elevated on six-inch blocks to favor downward drainage of urine and stools. No change in the feeding formula is indicated except that smaller quantities should be given for two days and the mother should be warned that the baby is likely to vomit. After two or three weeks the first plaster should be replaced by a second, applied in exactly the same manner except that the thigh on the side of the hemivertebra need not be included. This plaster can usually be left on for five weeks, and a third for a still longer period.

In the fourth case of the series, which proved particularly resistant

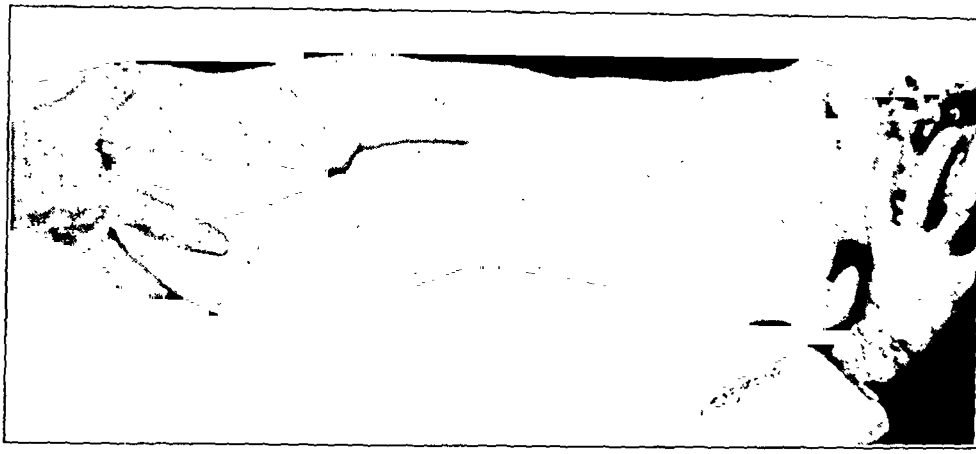

FIG. 7

Case 4. A. K., after one year of treatment. The curvature and the pelvic obliquity have been entirely corrected.

and required immobilization in plaster for over a year, the routine method of applying the plaster had to be modified because the patient developed a mild adduction contracture of the left hip. To overcome this, the plaster was applied in two stages. First, a short spica was applied to the left hip with the thigh abducted 20 degrees. This spica extended upward to the level of the second lumbar vertebra and included a heavy felt pad over the apex of the right lumbodorsal curve. No attempt, however, was made to correct the scoliosis until the plaster had set. Correction was then accomplished, as illustrated in Figure 4, by depressing the left side of the pelvis, swinging the left side of the chest upward and toward the right, and

FIG. 8

Case 1. M. H., at age of nine years. Photographs illustrating the normal appearance of the back and the normal range of motion, despite the presence of a hemivertebra.

exerting a strong pull to the left over the apex of the curve by means of a muslin sling. When correction had thus been obtained, plaster was applied, including the spica and extending up to the axillae.

Immobilization in plaster should be continued until the child lies naturally in a position of overcorrection. Then a light removable corset should be applied. The author has employed a modification of the quadrilateral-frame corset used at the Children's Hospital in Boston. When this corset has been fitted, the child may sit up and begin walking. Massage, manipulation, and exercises help to limber up the spine and restore muscle tone. The corset should be worn several years until all trace of deformity has disappeared.

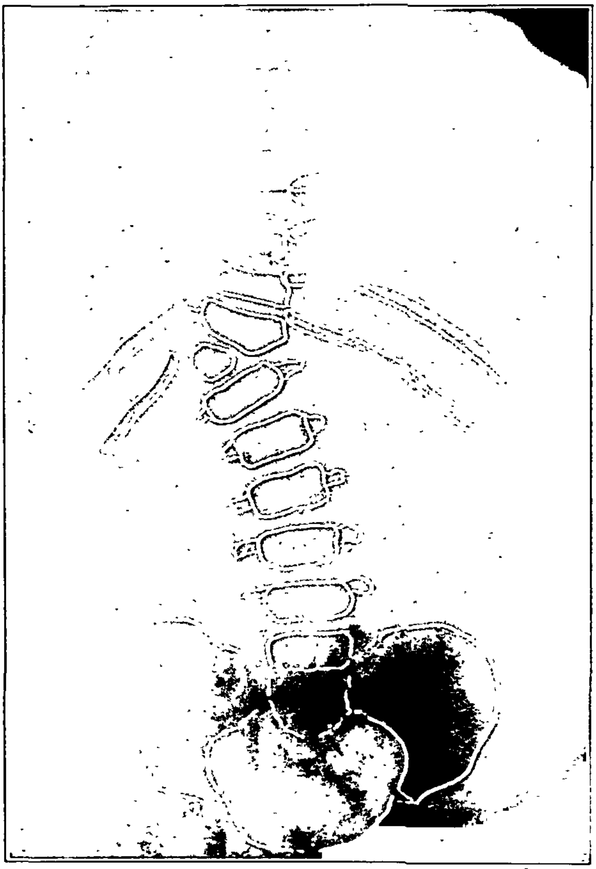

FIG. 9

Case 1. M. H., roentgenogram illustrating the good alignment of the spine, despite the persistence of the hemivertebra.

CASE REPORTS

CASE 1. M. H., a girl, aged seven months, was first seen on June 18, 1925. Examination showed marked right lumbodorsal scoliosis with its apex situated in the region of the twelfth dorsal vertebra. The roentgenogram showed a hemivertebra situated between the twelfth dorsal and the first lumbar vertebrae on the right side. The patient had been seen by the late Dr. Russell Hibbs who advised a resection of the hemivertebra.

Treatment consisted in the application of plaster-of-Paris corsets; thus immobilizing the back in overcorrection from June until September. Then a quadrilateral brace was fitted which was worn for the next two and one-half years. Since that time the child has been entirely without support.

The roentgenogram reveals a persistence of the hemivertebra and the development of two sharp counter curves above and below the abnormal vertebra.

External examination shows no deformity whatever of the spine. All motions are free. There is three-eighths of an inch of shortening of the left leg, which is entirely

compensated by a corresponding lift in the shoe. The patient is able to participate in all forms of exercises and has no complaints (Figs. 8 and 9).

CASE 2. E. K., a boy, aged two and one-half years, was first seen September 2, 1926. Examination showed a marked right lumbar curve, due to a hemivertebra situated between the twelfth dorsal and first lumbar vertebrae. This curvature had been noted when the child was several months old and the parents had been told that he would outgrow it. Despite this prediction, however, the curvature had tended to increase.

Treatment consisted in the application of plaster-of-Paris jackets for a period of four months. A quadrilateral brace was then applied. This brace was worn for about a year and exercises were given.

When examined in 1934, eight years later, the patient showed externally no deformity whatever and no restriction of spinal motions. The roentgenogram showed a hemivertebra with a sharp counter curve above and below.

CASE 3. I. B., a girl, aged eight and one-half months, was first seen in March 1931. This patient was brought for treatment because of an apparent shortening of the left leg which had been diagnosed by the family physician as a congenital dislocation of the hip.

Examination showed that, in reality, the shortening was not due to a dislocation, but to a congenital scoliosis, convex to the right with a consequent upward tilting of the pelvis on the left side. The roentgenogram showed a hemivertebra situated at the lumbodorsal junction.

Plaster-of-Paris corrective jackets were applied over a period of eleven months, after which the patient was given a quadrilateral corset.

When last seen in September 1934, the patient's back was quite straight. There was no pelvic tilt and spinal motions were free in all directions. The roentgenogram showed a persistence of the hemivertebra.

CASE 4. A. K., a boy, aged four months, was first seen on November 14, 1933. The patient's father, a physician, had noted a curvature of the spine immediately after the birth of the child. Examination showed that the right side of the pelvis was three-quarters of an inch lower than the left side and that the left leg was apparently three-quarters of an inch shorter than the right leg. The spine showed a total curve, convex toward the right side. By gentle manipulation, it was possible to correct the curve.

Treatment consisted in the application of a series of plaster-of-Paris casts until January 5, 1935. A total of twelve plasters were applied.

Figure 7 shows the clinical end result,—complete correction of the deformity. As shown by the roentgenogram (Fig. 6), despite the persistent hemivertebra, the pelvic obliquity has been overcome and the alignment of the vertebrae is such as to assure a vertical line of the back.

SUMMARY

In four cases of congenital scoliosis in young children, due to a hemivertebra situated at or near the lumbodorsal junction, a functional cure has been accomplished by plaster-of-Paris corrective spicas. Anatomical cure by removal of the hemivertebra, as advocated by Compere, von Lackum and Smith, and Hibbs, is an unnecessary procedure in young children, since the non-operative method gives a perfect functional result despite the persistence of the hemivertebra.

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A MODIFICATION OF WHITMAN'S TREATMENT FOR FRACTURE OF THE NECK OF THE FEMUR

BY G. PERCIVAL MILLS, F.R.C.S., BIRMINGHAM, ENGLAND

It is universally recognized that apart from operation, for which the need has not yet been proved, the only way of securing satisfactory bony union in a fracture of the neck of the femur is that advocated by Whitman. The technique is well known to every surgeon and the results in skilled hands are excellent. It is, however, a form of treatment which makes heavy demands on the surgeon's skill in the use of plaster, on the patient's fortitude in enduring an uncomfortable position, and on the sister's ability to nurse a patient half of whom she can neither see nor touch. For these reasons the treatment is apt to be interrupted by unpleasant complications, avoidable perhaps in an orthopaedic clinic where everyone is familiar with the management of such cases, but likely to occur in the wards of a general hospital where officers with less specialized training may have the management of fractures.

The official Whitman plaster case extends from the mid-thoracic region to the toes of the affected limb and, although special arrangements of slings and pulleys have been contrived to move the patient about, it is at best a clumsy form of retentive apparatus. Its extreme length renders breakage probable unless it is made very heavy, and its dependence on control of the foot to secure internal rotation often gives rise to uncomfortable pressure symptoms. Moreover, the rigid fixation of the knee with an internal rotation strain upon it causes a stiffness which may persist for a long time.

It is evident, therefore, that a method of fixation which maintains the position of the hip but leaves the knee and leg free will have considerable advantages. Such a method is as follows:

Under general anaesthesia, a Kirschner wire is passed transversely through the upper part of the condyles of the affected femur. The "horseshoe" is attached, the wire stretched and made fast, and the ends cut off flush with the horseshoe. By the use of this horseshoe, an assistant then makes traction, rotation, or abduction as required while the surgeon disimpacts (if necessary) and reduces the fracture. It is remarkable how much easier the manipulation is when one has absolute control of the femur in this way instead of having to control it through the ligaments of the knee joint. Moreover, if the wire has been passed accurately in the transverse plane, one can see at a glance the exact degree of rotation without the complication of intervening ligaments which will probably be stretched.

When reduction is effected, the position of abduction and internal rotation is easily maintained by the assistant who controls the horseshoe. The knee may be allowed to flex, but the leg should be supported for,

Fig. 1
Fracture before reduction.

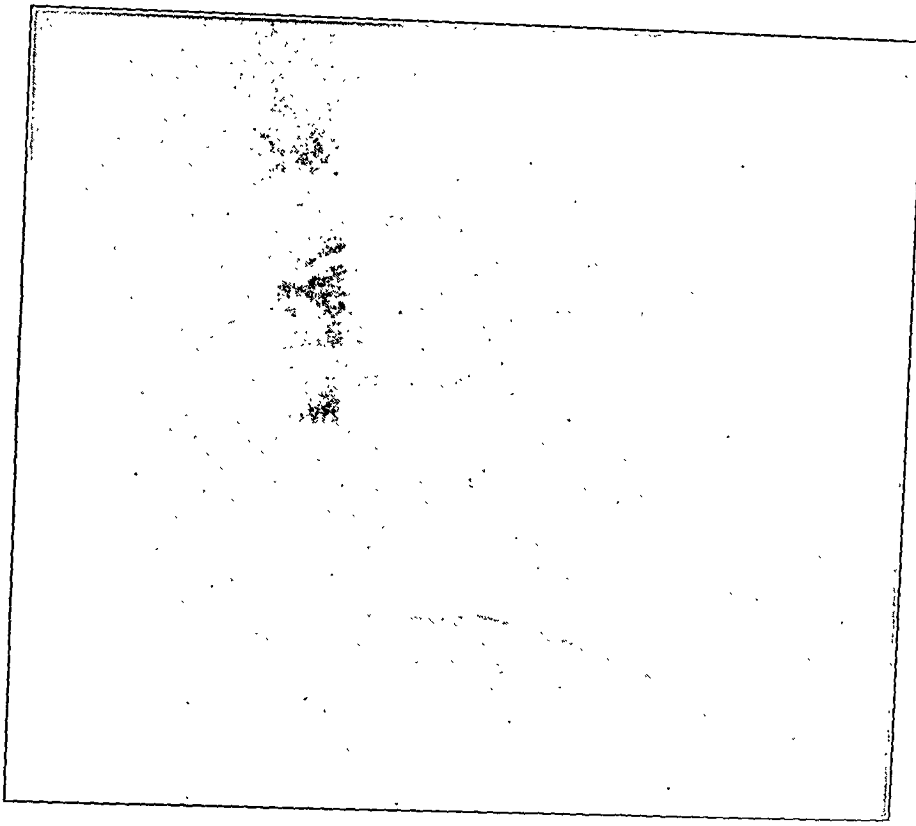

Fig. 2
Same case as Fig. 1. After reduction.

owing to the internal rotation, it does not hang vertically. A plaster case is then applied exactly as in Whitman's method, but extending on the front and sides of the thigh only to the level of the femoral condyles, and on the back of the thigh to about three inches above this point, in order to permit flexion of the knee. The wire is firmly incorporated in the plaster which fits closely at the sides but rather loosely in front to leave room for the patella in extension. The horseshoe must, of course, be left in position to maintain the rigidity of the wire, and it forms a convenient attachment for a short sling to support the foot and prevent foot drop.

It is again remarkable how much easier it is to apply this than a Whitman plaster. The hands of the assistant are out of the way and there is no risk of losing correction while he removes his hands in order that the plaster may be applied underneath; nor does the subsequent pressure of his hands in maintaining correction threaten to produce dents in the plaster. The whole case is applied and molded without the possibility of disturbance of the fracture and, as it is barely two-thirds of the length of a Whitman plaster, it need not be made so heavy. It is usual to trim away the front of a Whitman plaster over the thorax to allow the patient to be propped forward to some extent and, with the extra fixation obtained by the wire, it has been found safe to do this to a greater degree than before.

Fig. 3
Showing patient with plaster case applied.

The patient is placed in bed with the knee of the affected limb at the edge and the foot resting on a low stool and supported by the sling referred to previously. He flexes and extends the knee from the first and maintains the muscle tone by frequent movements of the foot, so that when the case is removed there is no stiffness to be overcome.

The advantages of this method are as follows:

1. Reduction of the fracture is much easier with the better control of the femur given by the wire.
2. The plaster case is applied with the greatest ease and the fracture is controlled during the whole of its application.
3. The patient finds the case much more comfortable than a long plaster and pressure sores are much less likely to occur.
4. The knee and ankle can be moved freely from the first.

A SYNERGICAL SPLINT WITH TRACTION FOR FEMORAL FRACTURES

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A great difficulty in the treatment of femoral fractures by the modern methods of skeletal traction and suspension of the limb is the maintenance of the correct relation of the two mechanical systems. The two types of splints most commonly used in this treatment are:

1. A splint suspended from a frame and attached to the patient (Thomas and others).
2. A splint placed on the bed and independent of the patient (Ziegler, Braun, etc.).

In both types, the traction is independent of the suspension, and the position of the limb in the splint is of essential importance for the maintenance of the fragments. Hence there is need for intelligent and constant vigilance on the part of a specially trained nurse during the entire period of the application of traction.

Although they are more difficult to install and to supervise, suspended splints are the better and the most comfortable for the patient, since they follow his movements.

Splints which are placed on the bed are simpler, but are more easily displaced and produce a recurvature of the fragments whenever the patient has need to rise.

The writer has coordinated the tractional system with the suspended splint, thereby solving the mechanical difficulties of the two methods. The synergical suspended splint accompanies every movement of the patient, maintains constant traction, and, since it cannot lose its adjustment, renders special vigilance unnecessary. The knee moves easily, the degree of flexion and the direction of the traction are adjustable at will, and the reestablishment of the femoral arch is easy. The splint can be extended and adapted to both limbs, thus meeting all requirements. Other modifications and simplifications in the general technique of wire extension and suspension will be described.

It is the purpose of this paper to present: (1) the modifications in the general method of wire extension which the author has found to be of value; and (2) a detailed description of the mechanics and application of the synergical splint.

SIMPLIFIED WIRE EXTENSION

Under this heading will be considered the method of perforation, the construction of the tension arches, the system for fixing the wire, and the means of tightening it.

Experience has led to the conclusion that the bone will stand wire of

a diameter of 1.5 millimeters, when used for extension, almost as well as that with a diameter of 1.0 or 0.75 millimeters. Therefore, the author uses exclusively wire of a diameter of 1.5 millimeters. Because of the rigidity of the wire, the mechanism for maintaining the alignment of the wire during the perforation can be dispensed with, thus avoiding this complication. For this purpose, the calipers alone will suffice.

As has been described in another paper [1], these calipers (Fig. 1, *A*) consist of two parallel arms attached by a bar on which one arm slides and is adjustable by means of a screw. At the end of the fixed arm there is a hollow steel needle, 17 millimeters in length, with an internal diameter of 1.5 millimeters, and bevelled at the free end. With this needle, at the point at which it is desired to place the extension, the skin is pierced as far as the periosteum. This perforation serves as a shaft for the wire, the rigidity and direction of which it maintains during the boring operation. At the end of the movable arm, there is another needle of equal length, but solid and set below the axis of the other, so as not to impede the exit of the perforator. The object of the second needle is to determine the point opposite the puncture. Since the needles meet practically in the same line because of the parallelism of the arms of the calipers, the direction given to the perforating wire is exact; and the shape of the needles, whose points press against the periosteum, permits the fixing of the compass without an appreciable deviation. The boring is as easy in the case of a normal surface as in that of an oblique surface, as well as in the case of multiple small bones, such as the metacarpus, where the setting of the wire is extremely difficult.

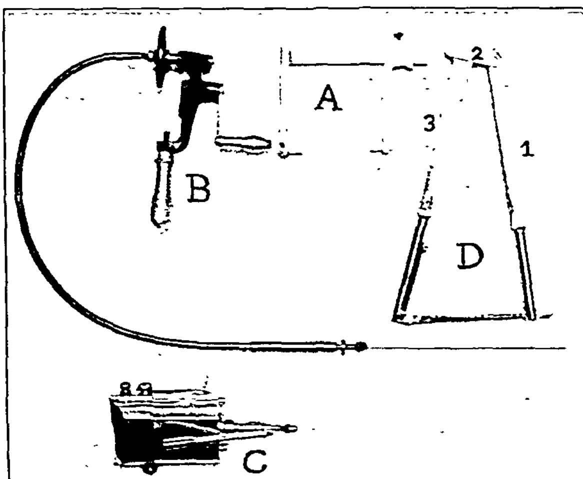

Fig. 1

Accessories for simplified wire extension: *A*, calipers; *B*, hand-drill; *C*, electric motor; *D*, wire tightener.

In the absence of the necessity for maintaining the rigidity of the wire, a rotary contrivance alone suffices for the perforation. The author prefers an electric motor to which is attached a small instrument in which the wire is mounted (Fig. 1, *C*). An apparatus worked by hand (Fig. 1, *B*) is sometimes used. This consists of a multiplying gear with a small fly-wheel and flexible transmission to the handle where the wire is mounted. The handle is turned rapidly by an assistant, while the surgeon

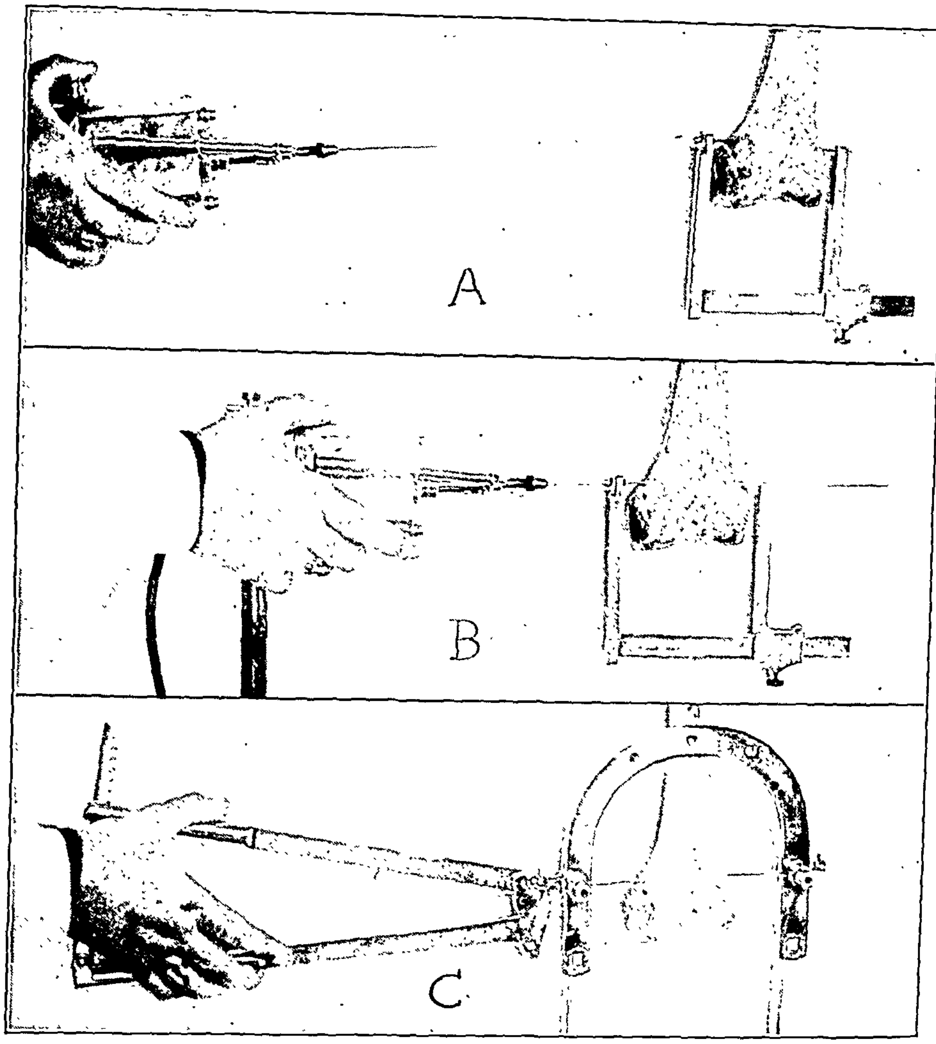

FIG. 2

Showing method of perforation: *A* and *B*, stages in boring the bone; *C*, tightening of the wire.

manipulates the calipers and the wire carrier. He thus makes the perforation without being disturbed by the movements of the assistant.

All of the mechanical means by which the surgeon himself is responsible for the rotation have been abandoned; he needs to have his hands free to perfect the perforation. Because of their lack of speed, hand-drills consume too much energy, especially in the case of hard bones, and, because of the vibration, it is difficult to guide them accurately. Except in the case of very soft bones, these hand-drills are difficult to work and are inefficient.

The method of maintaining the tension of the wire and fixing it to the traction arch has been modified. In the author's opinion, the use of self-tightening arches is unnecessary, since it renders them more complicated and costly, and since the wires, when once well set, do not slacken. The tightening of the wire requires but one effort; therefore, it is not necessary to have a tightening apparatus for every arch used. It is more practical to have one powerful and simple apparatus to tighten all arches in use in

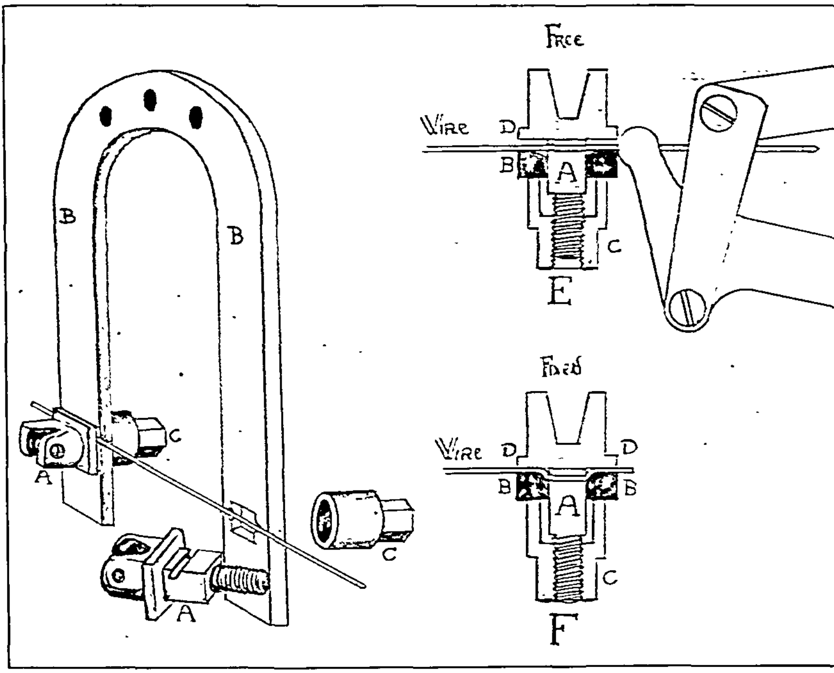

Fig. 3
Diagram showing method of tightening the wire by bending it.

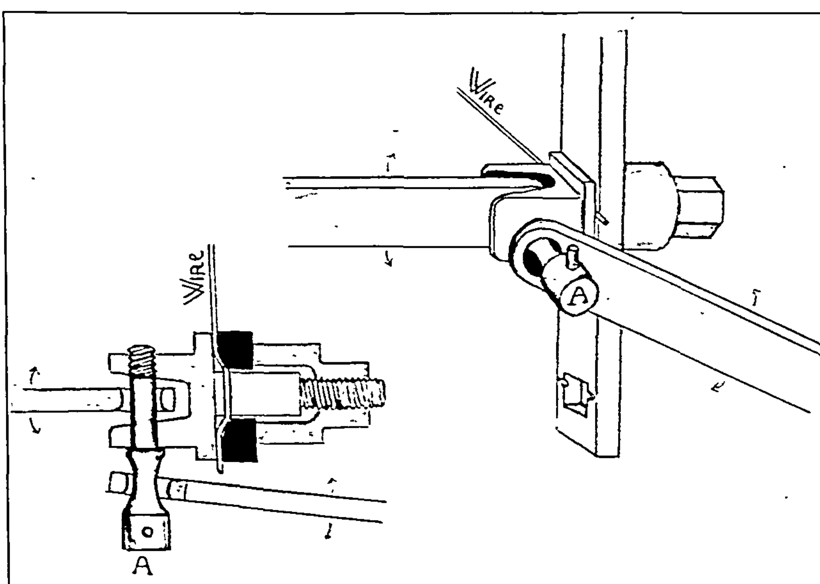

Fig. 4
Showing details of the universal joints.

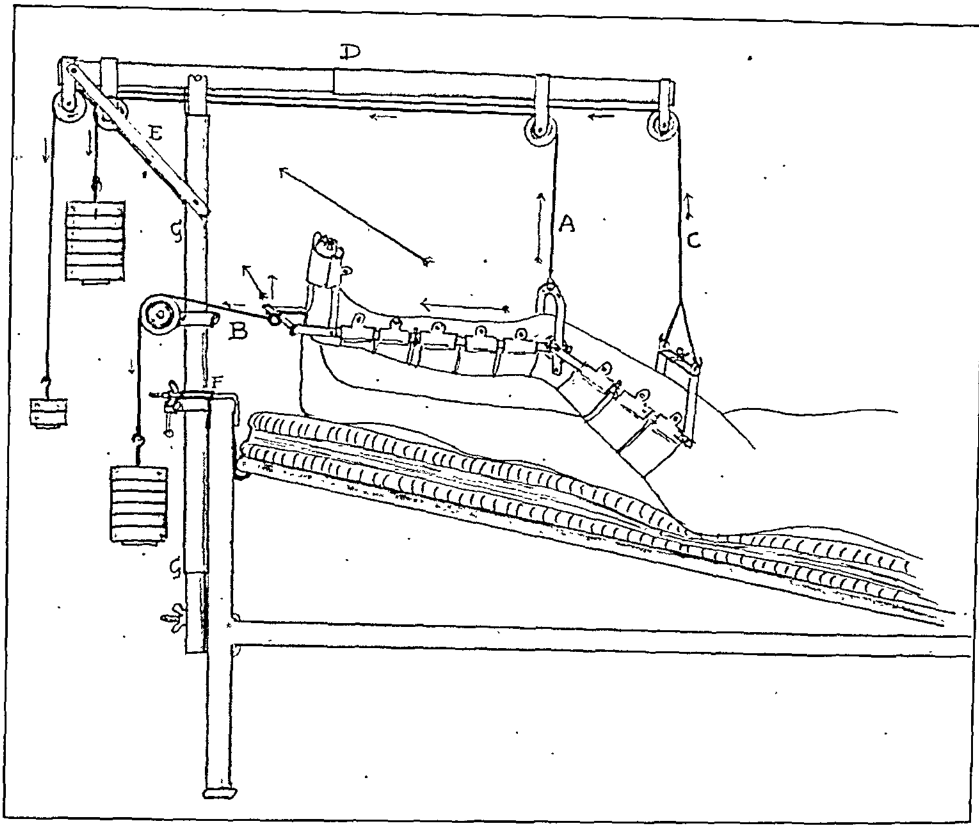

FIG. 5

Diagram of the synergical splint, showing the lines of force and the suspension frame.

the clinic. Such an apparatus has been designed and constructed, based on a triple system of levers joined in such a way that a single movement suffices to seize and tighten the wire (Figs. 1, *D* and 2, *C*). The wire is grasped by closing levers 1 and 2, and further pressure of levers 1 and 2 on lever 3 produces the tension, since lever 3 is supported against the arch. A single movement—the closing of the pincers after the wire is placed in position—secures a strong tension which is maintained by means of a ratchet until it is fixed in the arch.

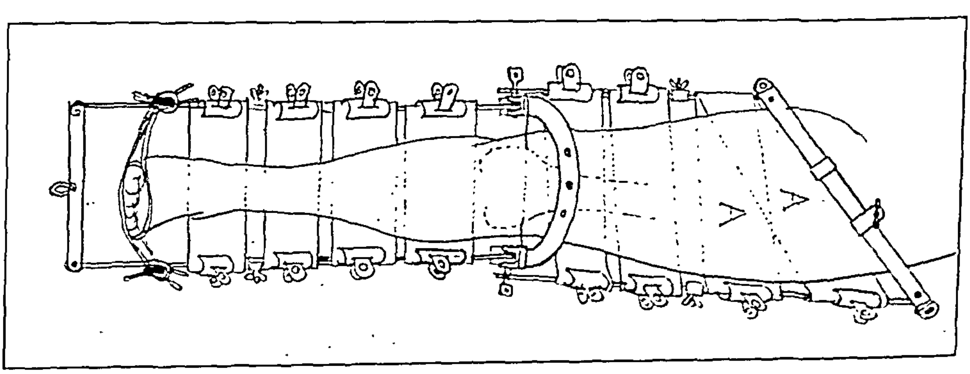

FIG. 6

Front view of the splint with the hammock.

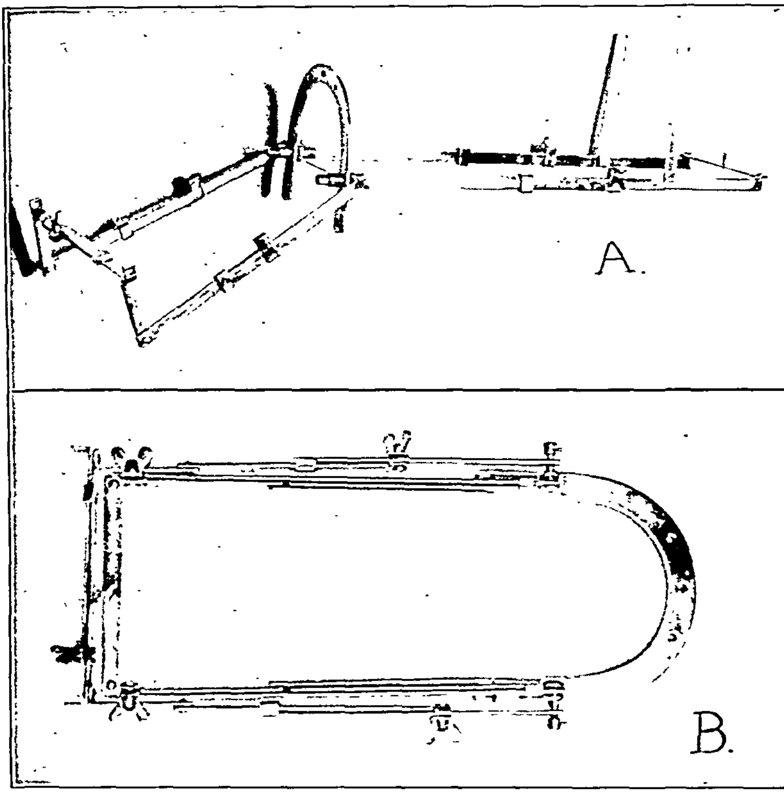

FIG. 7
Synergical splint: *A*, open; *B*, closed.

Finally, the construction of the traction arches has also been simplified. It is well known that the manufacture of complicated parts, requiring different thicknesses of steel, considerably increases the cost of construction. The arches described are made of steel plate of an uniform thickness of six millimeters. Secure fixation of the wire has been obtained, not by simple pressure, but by bending the wire. This method is shown in Figure 3. The wire passes along a groove cut in the square stem of a screw, *A*, two millimeters from its head. When the head, *C*, is turned, the wire is first bent and then held between the base, *D*, and the tightening arch, *B*, so that slight pressure is required and slipping is impossible. *E* and *F* show the system of fixing the wire.

SYNERGICAL SPLINT

The principle upon which the synergical splint (Fig. 5) is based is the use of an arch to obtain skeletal traction by means of a wire fixed to the knee in a vertical position. The two splints for the leg and thigh are attached to the arch by means of an universal joint (Fig. 4). Two forces act on the arch,—the vertical force, *A*; and the horizontal force, *B*. The resultant of the two forces (which depends on their potency and the

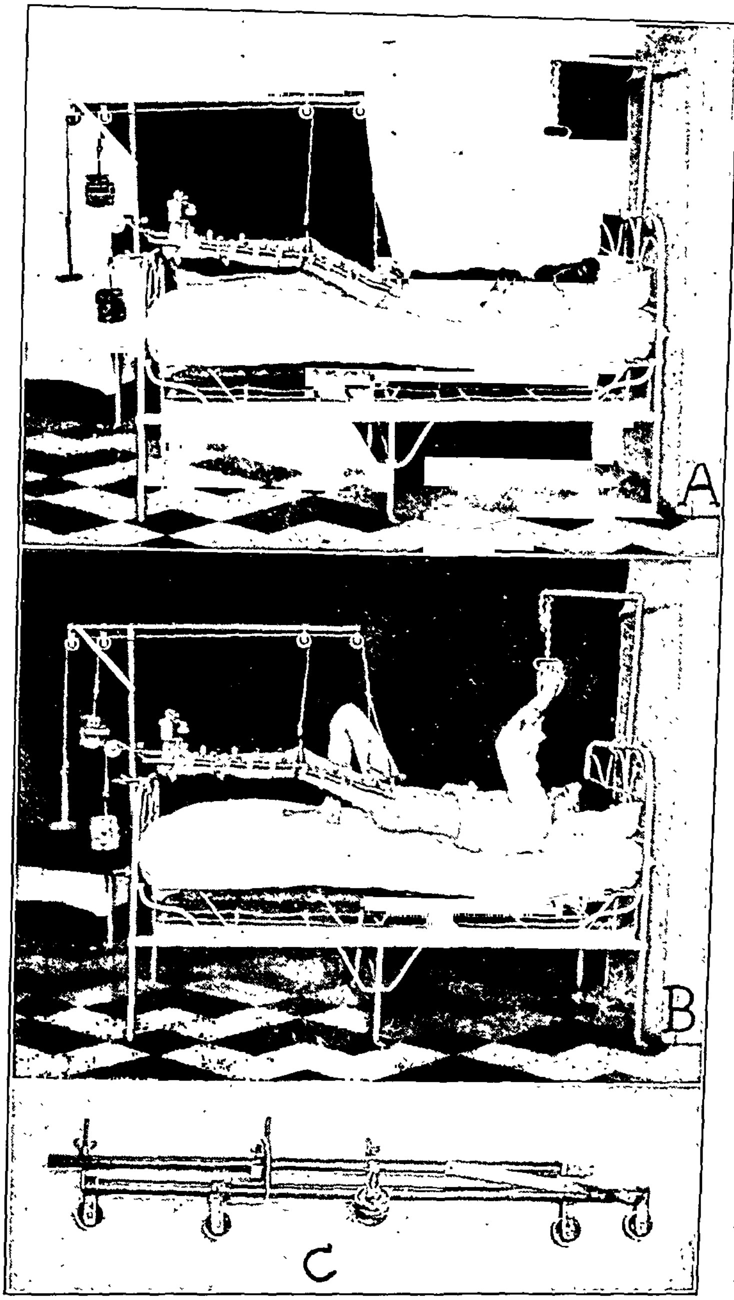

Fig. 8

Patient with the splint in position: *A*, resting; *B*, raising himself for toilet. *C* shows the frame when folded.

resistance which they have to overcome) should lead to the lengthening of the femoral axis, and regulates the traction. The use of the resultant of these two forces suggests the Russell method for the treatment of fractures in children.

The normal position is the classic one: semiflexion of the thigh on the trunk and of the leg on the thigh; in the case of a fracture of the lower femur, however, the angle may be greater, even reaching a right angle. This is important in children, especially when a double fracture is concerned. The action of the traction on the deviation of the fragments caused by the muscles is well understood. It must be borne in mind that the efficacy of the traction is increased by the absence of any friction. For this reason, the degree of abduction of the peripheral segment in a fracture of the upper portion of the limb need not be very pronounced; thus greater ease is provided for the patient.

As stated, the principle of this splint is the coordination into one system, mechanical and dynamic, of traction on the fracture and suspension of the limb. This has been accomplished as follows:

The suspension requires a support on which the affected part can rest, with a vertical pull to balance its weight. In this splint the necessary force is applied at three points: on the thigh (Fig. 5, *C*), at the knee (Fig.

5, *A*), and to the foot (Fig. 5, *B*). The first two forces produce a purely vertical traction; the third is a component of the horizontal traction, *B*, which, because of its weight and the shortness of the cord, is also practically vertical.

The support on which the limb rests is formed by the two splints attached to the tightening arch, to which strips of flannel are fastened by means of paper clips so as to form a hammock (Figs. 5 and 6). This hammock supports the weight of the limb and relieves the wire of part of its function. In this way, the rôle of the wire is to maintain constant the relation of the limb to the splint, so that, because the splint is attached to the bone, displacement of the hammock is impossible. Two vertical rods, attached to the foot of the splint, support the foot and prevent equinus.

The resultant of the two forces, horizontal and vertical, applied directly to the tightened wire, produces the extension. The vertical traction acts directly on the arch itself; the horizontal traction is obtained by means of the leg splint and its joints. It is not, however, sufficient to

FIG. 9-A FIG. 10-A FIG. 11-A

Three cases of high fracture of the femur before operation.

FIG. 9-B FIG. 10-B FIG. 11-B

The same three cases after operation.

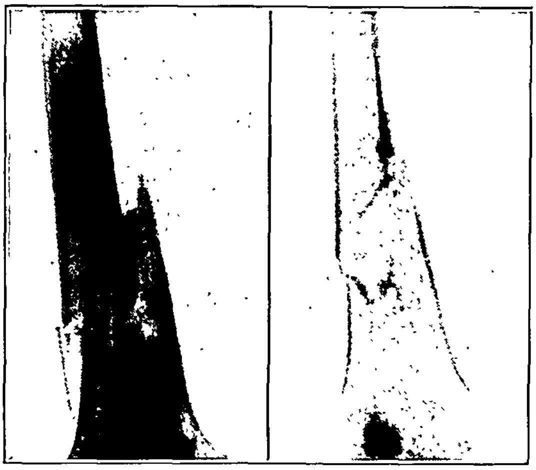

FIG. 12-A
Before operation.

FIG. 12-B
After operation.

Figs. 12-A and 12-B: case of fracture by shot;
Figs. 13-A and 13-B: case of comminuted fracture;
Figs. 14-A and 14-B: another case of comminuted fracture;
Figs. 15-A, 15-B, and 15-C: correction of shortening caused by malunion; end results obtained by osteotomy with small pegs and extension.

FIG. 13-A
Before operation.

FIG. 13-B
After operation.

FIG. 14-A
Before operation.

FIG. 14-B
After operation.

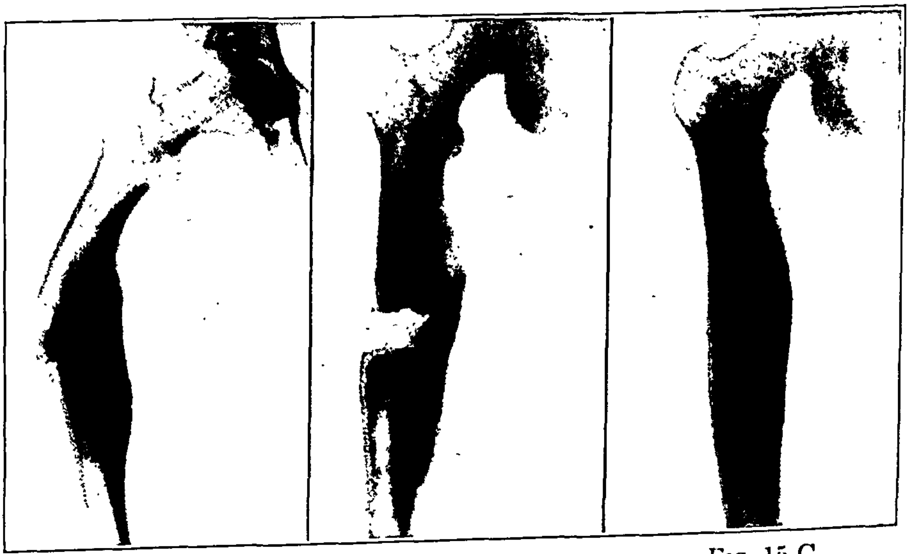

FIG. 15-A

FIG. 15-B

FIG. 15-C

rely on simple pulling of the wire. In order that the wire may not injure the bone or soft parts, it must be in line with the traction; and this alignment varies with every setting up of the apparatus and the extension. All rigidity in the splint, except along the lines of force, should be avoided. Thus the splint automatically adapts itself to all requirements. With this in view, the author's model was made jointed and extensible, so that it might be adaptable not only to various statures, but also to varying positions of the bone. In fact, while exerting the traction, the wire floats in space, thus permitting to the patient much greater mobility than that enjoyed under other systems.

The splint requires two angular joints at either end, to adapt it to the limb, and two universal joints (one on each side of the knee), to permit the wire to float and thus insure efficient traction; the universal joints also maintain the splint firmly in position. These joints are shown in detail in Figure 4.

The splint must be suspended by a frame; consequently, a simple frame, easily folded and adaptable to any bed (Fig. 8, *A*, *B*, and *C*), has been designed. It consists of an extensible arm, to which is attached the mechanism for traction on the knee and thigh. Figure 5 shows the frame in detail. The arm is held by two supports, *E*, and attached by a third, *F*, to the extensible rod, *G*, which is fixed to the bed at the desired height and degree of abduction. To this rod, *G*, is attached the pulley for horizontal extension. The counterextension is produced by inclining the mattress on which the patient is lying, while the bed is maintained in its horizontal position.

A detailed description of the manner in which the apparatus is set up is not necessary; a short description is sufficient to give an accurate idea of the procedure. After the perforation of the bone, under spinal or local anaesthesia, the splint is placed in position and adjusted to fit the patient. The skin is cut to prevent necrosis and rolls of sterilized gauze are placed over the two orifices where the wire has entered. The gauze is soaked in a solution of mercurochrome. The hammock is then set up with the strips of flannel (Fig. 6), the first of which, *A*, is passed back over the inside edge of the splint, so as to adapt it to the shape of the thigh and to avoid any inconvenient rubbing on the inner surface against the other thigh. Another strip, held on special supports, is also placed beneath the sole of the foot to prevent equinus.

Experience has shown the utility of this method, as well as the degree of comfort which it offers the patient (Fig. 8, *A* and *B*).

Figures 9 through 15 show the end results obtained by this method in seven cases of fracture of the femur.

SUMMARY

In cases of fracture of the femur, skeletal traction of the femur and suspension of the limb have been harmonized mechanically and dynamically by means of a simple adjustable splint which does not require special

vigilance and which permits movements of the knee and the use of physiotherapy, thus giving more comfort and greater freedom of movement to the patient. At the same time, the traction is efficiently maintained and all disturbances at the seat of the fracture are avoided.

1. H-Ros Codorniu, A.: Tratamiento de las fracturas de tibia y peroné según un método de fijación directa y extrafocal de los fragmentos óseos. Rev. de Cir. de Barcelona, III, 379, 1932.

THE USE OF COLLOIDAL SULPHUR IN THE TREATMENT OF ARTHRITIS

BY THOMAS WHEELDON, M.D., RICHMOND, VIRGINIA

PART II

Sulphur has been used in the treatment of 892 cases of arthritis during the past four years by the writer; in the observation and study of these cases the following suggestive data were collected.

Part I of this paper (Wheeldon and Main[1]) dealt with the toxicological studies of clinical doses of certain sulphur preparations (Sulfur-Diasporal) used in the treatment of arthritis. The present paper, Part II, has to do with observations of the results of treatment of arthritis with sulphur (892 cases).

Some other workers who have written upon the treatment of arthritis with colloidal sulphur are Meyer-Bisch[3], Sullivan and Hess[4], Senturia[5], Monaghan and Garai[6], Woldenberg[7], Argy[8].

It is now suggested by the writer that at least some, if not all, forms of arthritis are made possible by a sulphur deficiency, particularly in the cartilage of the joints; that, given a sufficient sulphur reserve to combat the contributing etiological factor, arthritis would not occur; and that, whether there is a sufficient sulphur reserve or not depends upon the ability of the intestinal tract normally to absorb sulphur. It was at first thought that the effects of the intravenous and intramuscular administration of sulphur were achieved directly. Woldenberg[7] holds that normal sulphur metabolism takes place in three phases. Neutral sulphur is disassociated from protein. He states that about 20 per cent. is eliminated unchanged in the urine and 20 per cent. is eliminated unchanged in the faeces. The rest of the neutral sulphur is further oxidized and then, on complete oxidation, forms sulphuric acid which combines with certain alkaline bases and is eliminated in the urine in the form of sulphates. The following suggestions are now offered: that probably the first phase of normal sulphur metabolism is more important than was at first thought: that it is through the effect of the sulphur eliminated in the intestinal tract, following intravenous or intragluteal administration, upon the contents of the intestinal tract that a condition is created conducive to the proper normal absorption of sulphur; and that this sulphur which is then absorbed from the intestinal tract is a greater factor in building up the sulphur reserve than any sulphur which may have been further oxidized as described by Woldenberg[7].

ADMINISTRATION

The same technique has been used over a period of four years, and the freedom from unpleasant experiences justifies a brief description of this

CHART 1-A

COMBINED DETERMINATIONS IN TWENTY-FIVE CASES OF THE HYPERTROPHIC TYPE

Case No.	Age	No. of Doses of Sulphur	Cystine Sulphur		Blood Calcium		Blood Sugar		Metabolism		Sedimentation		Indican		R. B. C.		W. B. C.		Hemoglobin		Wassermann		Blood Pressure		Weight		X-Rays	
			Before	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*
1	58	40	9.6	10.3	8.6	9.8	135	105	−7	+5	17	8	0	+4	39	45	80	62	90	90	neg.	neg.	160/60	130/60	138	138	same	
2	52	40	9.3	12.4	9.5	12.5	100	90	+9	+1	30	12	0	0	42	42	70	70	80	85	neg.	neg.	150/70	150/100	137	128	same	
3	51	40	9.4	12.6	10.0	10.0	100	100	−19	−4	32	6	0	0	38	45	48	82	80	80	neg.	neg.	120/80	130/80	103	101	same	
4	60	40	9.7	13.4	10.4	13.5	85	85	−31	−11	25	16	0	+2	48	48	78	95	65	95	neg.	neg.	200/110	170/100	162	158	same	
5	64	40	9.2	11.1	10.6	10.0	115	110	−21	−12	23	28	0	+1	36	40	80	66	80	75	neg.	neg.	120/80	120/80	149	150	same	
6	63	40	10.2	12.1	10.7	11.9	82	100	−19	−17	38	12	+1	+5	44	46	88	63	70	75	neg.	neg.	178/84	140/80	126	127	same	
7	61	40	9.4	11.1	10.0	10.0	150	155	−3	+5	8	8	0	+3	29	40	54	49	80	60	neg.	neg.	150/85	140/80	192	180	same	
8	63	40	10.6	12.1	10.1	11.1	150	120	+5	−6	33	12	0	+2	46	40	68	61	85	85	neg.	neg.	155/60	155/60	230	210	same	
9	69	40	8.3	9.4	10.1	8.4	105	100	−3	+3	20	8	0	+4	42	39	80	63	80	75	neg.	neg.	182/130	150/65	159	152	same	
10	62	40	9.8	13.2	10.3	10.4	140	85	−5	−5	24	6	0	+3	42	48	85	79	90	85	neg.	neg.	148/86	130/80	174	169	same	
11	61	40	9.2	10.8	7.6	11.0	110	125	+29	+30	23	9	0	+5	48	41	85	76	90	85	neg.	neg.	150/90	140/80	160	160	same	
12	53	40	9.8	12.2	11.3	10.1	90	100	−10	−15	20	23	0	0	54	41	56	61	90	80	neg.	neg.	148/90	130/70	118	120	same	
13	61	40	8.3	12.3	9.5	10.3	80	95	−18	−4	37	12	0	+4	41	46	82	110	90	95	neg.	neg.	110/60	140/90	155	140	same	
14	53	40	10.1	13.6	13.7	8.9	85	105	−8	−13	37	18	0	0	44	43	82	83	90	80	neg.	neg.	135/65	110/70	127	128	same	
15	61	40	8.4	11.1	10.0	10.0	130	125	−6	−6	12	12	0	+3	40	40	55	50	80	79	neg.	neg.	155/85	155/85	192	184	same	
16	55	40	9.2	11.0	13.6	9.0	90	110	−8	−10	31	14	0	0	44	43	82	83	90	80	neg.	neg.	145/75	115/70	132	127	same	
17	61	40	8.7	10.9	9.5	10.3	80	95	−18	−4	37	35	0	+3	40	45	82	75	90	95	neg.	neg.	110/60	110/90	155	155	same	
18	52	40	8.6	10.9	11.3	11.1	92	100	−10	−15	20	23	0	0	54	46	51	73	90	80	neg.	neg.	118/90	105/82	119	120	same	
19	61	40	10.0	11.9	10.8	11.3	85	100	−17	−16	35	8	0	0	47	40	88	81	70	75	neg.	neg.	178/81	110/80	127	124	same	
20	58	40	8.2	10.8	8.6	11.0	120	125	+29	+10	28	9	0	+5	48	46	85	76	90	85	neg.	neg.	150/90	155/85	160	160	same	
21	55	40	10.0	13.2	10.3	11.4	95	85	−2	+5	27	12	0	+3	43	48	85	82	90	85	neg.	neg.	140/80	140/80	174	169	same	
22	70	40	8.3	9.4	10.1	9.4	105	100	−5	−5	21	12	0	+4	42	44	80	82	80	75	neg.	neg.	175/65	150/65	152	157	same	
23	55	40	9.1	12.2	10.1	10.9	105	100	+6	−5	33	11	0	+3	46	40	68	75	85	85	neg.	neg.	138/60	155/60	210	190	same	
24	51	40	8.9	11.5	9.0	11.6	90	90	−4	+3	43	29	+1	+5	50	50	86	90	90	85	neg.	neg.	100/65	150/65	150	156	same	
25	51	10	9.1	11.1	9.1	12.5	100	90	+9	+1	32	18	0	0	42	42	70	70	80	80	neg.	neg.	155/70	150/100	137	128	same	

Chart I B

Combined Determinations in Twenty-Five Cases of the Proliferative Type

Case No.	Age	No. of Doses of Sulphur	Cystine Sulphur		Blood Calcium		Blood Sugar		Metabolism		Sedimentation		Indican		R. B. C.		W. B. C.		Hemoglobin		Wassermann		Blood Pressure		Weight		X-Rays
			Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before After
1	28	10	9.1	11.3	11.0	9.9	105	85	− 7	− 4	60	20	+1	+3	31	47	101	66	60	70	neg.	neg.	115/72	110/75	100	107	same
2	13	10	9.6	11.4	8.8	8.8	70	70	− 9	− 5	16	12	0	+1	45	41	88	80	85	80	neg.	neg.	130/70	120/80	141	131	same
3	33	10	9.2	11.9	11.9	10.0	100	110	− 1	+ 9	40	12	0	+6	46	46	87	51	85	75	neg.	neg.	115/80	120/80	127	113	same
4	17	10	9.5	10.4	10.5	11.2	85	117	−38	− 9	30	6	0	0	45	45	61	72	85	80	neg.	neg.	120/70	120/80	131	132	same
5	50	40	9.9	11.5	9.0	11.6	90	90	+ 3	− 4	29	10	+1	+5	50	41	86	90	90	85	neg.	neg.	160/75	110/80	150	143	same
6	18	10	10.2	10.4	10.8	9.6	190	110	−30	−11	6	6	0	+2	39	47	81	49	80	95	neg.	neg.	110/80	120/80	209	180	same
7	35	10	9.1	11.3	10.8	9.8	115	80	+15	+ 5	18	5	0	+5	39	40	56	90	80	75	neg.	neg.	120/80	120/80	101	106	same
8	23	10	10.6	11.7	11.0	11.0	100	100	+12	+ 5	15	8	0	+4	43	46	62	62	80	80	neg.	neg.	150/65	150/60	170	150	same
9	36	10	9.7	10.6	9.8	10.2	100	95	− 9	− 4	10	10	0	+2	46	48	82	80	85	85	neg.	neg.	120/80	120/80	126	128	same
10	17	10	9.6	11.0	12.2	11.0	95	75	− 3	+ 2	4	6	0	+5	44	44	106	86	90	90	neg.	neg.	115/70	120/80	176	172	same
11	32	10	9.2	10.6	10.9	9.2	75	75	+ 6	− 7	10	8	0	0	39	42	68	70	55	65	neg.	neg.	110/50	105/60	99	102	same
12	15	10	9.1	11.2	7.9	10.1	80	80	− 9	−15	25	10	0	+5	44	44	106	70	85	85	neg.	neg.	120/60	120/80	123	118	same
13	26	10	9.7	12.1	11.0	11.6	80	80	− 5	+ 5	21	10	0	+5	44	46	74	67	90	70	neg.	neg.	110/70	115/85	113	112	same
14	26	10	10.7	12.1	11.0	11.2	80	80	− 6	− 6	21	11	0	+6	44	44	74	67	85	80	neg.	neg.	110/70	115/85	113	112	same
15	35	10	7.9	11.1	11.5	10.5	80	80	−16	− 7	23	11	0	+5	48	48	82	80	85	85	neg.	neg.	120/60	120/80	123	118	same
16	30	10	9.0	10.9	10.6	9.2	75	75	+ 6	− 7	7	7	0	0	40	48	70	72	55	85	neg.	neg.	130/50	120/80	101	122	same
17	31	10	9.9	11.1	12.2	11.2	95	90	− 3	+ 4	18	18	0	+5	41	44	86	81	90	90	neg.	neg.	115/70	120/80	176	172	same
18	36	10	8.7	10.6	9.8	10.1	100	95	− 7	− 4	10	8	0	+2	48	48	80	82	85	80	neg.	neg.	130/80	125/80	131	125	same
19	25	10	9.8	11.7	11.4	11.4	100	100	− 4	− 4	18	16	0	+3	46	46	78	78	80	80	neg.	neg.	160/60	110/60	126	126	same
20	30	10	9.4	12.9	10.6	10.0	105	95	+10	+ 5	43	5	0	+5	45	46	112	95	80	85	neg.	neg.	120/80	120/80	118	120	same
21	30	10	10.2	11.2	10.8	10.0	120	110	−11	− 3	6	6	0	+2	39	47	81	79	80	95	neg.	neg.	110/80	110/80	190	165	same
22	27	10	9.5	10.4	10.5	11.4	85	107	− 9	−29	30	6	0	+2	45	45	66	72	85	80	neg.	neg.	120/80	130/60	163	150	same
23	23	10	10.6	11.4	9.2	9.2	70	70	− 9	− 5	18	11	0	0	48	49	80	70	85	80	neg.	neg.	130/70	130/70	141	140	same
24	28	10	9.8	10.8	11.0	9.9	105	85	− 4	− 4	60	45	0	+3	37	47	88	70	65	75	neg.	neg.	120/70	115/72	109	106	same
25	33	40	10.1	12.3	11.0	10.0	100	110	+ 9	− 1	39	16	0	+5	47	47	89	53	85	75	neg.	neg.	120/70	115/60	127	109	same

technique. The material used intravenously is stated to contain five milligrams of colloidal sulphur dispersed in two cubic centimeters of a protein-free aqueous medium; that used intramuscularly, to contain twenty milligrams of colloidal sulphur dispersed in two cubic centimeters of olive oil. Because the parenteral toxicity of colloidal sulphur depends upon its dispersion and the speed of injection, great care is taken that this injection be done slowly, at the rate of not more than one cubic centimeter per minute. Three injections of each solution (intravenous and intramuscular) are given each week, an injection of both intravenous and intramuscular being given during the same visit. For intravenous administration, the size of the needle used is 26-gage, five-eighths of an inch; while for the intramuscular administration, the size is 22-gage, one inch. Both solutions are heated to about 98.6 degrees Fahrenheit. In the intravenous medication, great care is taken at all times to make sure that the vein is entered by repeatedly withdrawing a little blood; and, after withdrawal of the needle, leakage is prevented by pressure over the site of the

CHART 2-A

CHANGES IN THE CYSTINE SULPHUR OF THE FINGER NAILS
IN TWENTY-FIVE CASES OF HYPERTROPHIC ARTHRITIS

Case No.	Before	After	Change
1	9.6 per cent.	10.3 per cent.	0.7 per cent.
2	9.3 per cent.	12.4 per cent.	3.1 per cent.
3	9.4 per cent.	12.6 per cent.	3.2 per cent.
4	9.7 per cent.	13.4 per cent.	3.7 per cent.
5	9.2 per cent.	11.1 per cent.	1.9 per cent.
6	10.2 per cent.	12.1 per cent.	1.9 per cent.
7	9.4 per cent.	11.1 per cent.	1.7 per cent.
8	10.6 per cent.	12.1 per cent.	1.5 per cent.
9	8.3 per cent.	9.4 per cent.	1.1 per cent.
10	9.8 per cent.	13.2 per cent.	3.4 per cent.
11	9.2 per cent.	10.8 per cent.	1.6 per cent.
12	9.8 per cent.	12.2 per cent.	2.4 per cent.
13	8.3 per cent.	12.3 per cent.	4.0 per cent.
14	10.1 per cent.	13.6 per cent.	3.5 per cent.
15	8.4 per cent.	11.1 per cent.	2.7 per cent.
16	9.2 per cent.	11.0 per cent.	1.8 per cent.
17	8.7 per cent.	10.9 per cent.	2.2 per cent.
18	8.6 per cent.	10.9 per cent.	2.3 per cent.
19	10.0 per cent.	11.9 per cent.	1.9 per cent.
20	8.2 per cent.	10.8 per cent.	2.6 per cent.
21	10.0 per cent.	13.2 per cent.	3.2 per cent.
22	8.3 per cent.	9.4 per cent.	1.1 per cent.
23	9.1 per cent.	12.2 per cent.	3.1 per cent.
24	8.9 per cent.	11.5 per cent.	2.6 per cent.
25	9.4 per cent.	11.1 per cent.	1.7 per cent.
TOTAL	231.70 per cent.	290.60 per cent.	58.90 per cent.
AVERAGE	9.27 per cent.	11.62 per cent.	2.35 per cent.

injection and elevation of the extremity for as much as five minutes. In the intramuscular injection, care is taken to avoid entrance of a vessel by reverse pressure on the plunger of the syringe prior to the administration, and care is also taken that a trail of material is not allowed to follow the needle out after administration. The syringe is removed from the needle before the needle is withdrawn, two or three cubic centimeters of air are drawn into the syringe, the syringe is reconnected to the needle, and the air is then driven through the needle into the tissues. This insures that all sulphur is driven out of the needle. After the needle has been withdrawn, the local area is gently massaged for two or three minutes. Great care is taken as to sterility of the local parts before injection, and needles and syringes are boiled for at least ten minutes each time before using. Separate syringes are always used for the intravenous and the intragluteal administration, and the same needles are never used to inject the material that are used to draw it up into the syringe.

With the above precautions taken into consideration, it can be stated

CHART 2-B

Changes in the Cystine Sulphur of the Finger Nails In Twenty-Five Cases of Proliferative Arthritis

Case No.	Before	After	Change
1	9.1 per cent.	11.3 per cent.	2.2 per cent.
2	9.6 per cent.	11.4 per cent.	1.8 per cent.
3	9.7 per cent.	11.9 per cent.	2.2 per cent.
4	9.5 per cent.	10.4 per cent.	0.9 per cent.
5	9.9 per cent.	11.5 per cent.	1.6 per cent.
6	10.2 per cent.	10.4 per cent.	0.2 per cent.
7	9.4 per cent.	11.3 per cent.	1.9 per cent.
8	10 6 per cent.	11.7 per cent.	1.1 per cent.
9	9.7 per cent.	10.6 per cent.	0.9 per cent.
10	9.6 per cent.	11.0 per cent.	1.4 per cent.
11	9.2 per cent.	10.6 per cent.	1.4 per cent.
12	9.4 per cent.	11.2 per cent.	1.8 per cent.
13	9.7 per cent.	12.1 per cent.	2.4 per cent.
14	10.7 per cent.	12.1 per cent.	1.4 per cent.
15	7.9 per cent.	11.1 per cent.	3.2 per cent.
16	9.0 per cent.	10.9 per cent.	1.9 per cent.
17	9.9 per cent.	11.1 per cent.	1.2 per cent.
18	8.7 per cent.	10.6 per cent.	1.9 per cent.
19	9 8 per cent.	11.7 per cent.	1.9 per cent.
20	9.4 per cent.	12.9 per cent.	3.5 per cent.
21	10.2 per cent.	11 2 per cent.	1.0 per cent.
22	9.5 per cent.	10.4 per cent.	0.9 per cent.
23	10.6 per cent.	11.4 per cent.	0.8 per cent.
24	9.8 per cent.	10.8 per cent.	1 0 per cent.
25	10.1 per cent.	12.3 per cent.	2.2 per cent.
Total	241.20 per cent.	281.90 per cent.	40 70 per cent.
Average	9.65 per cent.	11.28 per cent.	1.63 per cent.

that there are practically no local reactions as described by Waller and Allen [9], Monaghan and Garai [6], Senturia [5], Woldenberg [7], and Mackay [10]. The favorable experience as to absence of general reactions has been the same as reported previously [1]. No regular rise in temperature has been noted following this medication, nor has the prompt leukocytosis reported by Mackay been observed.

CHART 2-C

ANALYSIS OF CYSTINE SULPHUR DETERMINATIONS (FINGER NAILS)

		Before	After	Change
Series of 50 cases treated with sulphur for special investigation	Hypertrophic	9.27 per cent.	11.62 per cent.	2.35 (Rise)
	Proliferative	9.65 per cent.	11.28 per cent.	1.63 (Rise)
	Average	*9.46 per cent.*	*11.45 per cent.*	*1.99 (Rise)*
NORMAL	11.06 per cent. (Based upon 697 cystine-sulphur determinations, by the writer, without reference to arthritis.)			
NORMAL (Sullivan)	11.0 per cent. to 13.0 per cent.			
AVERAGE in a series of 341 arthritic cases treated with sulphur		*9.85 per cent.*	*11.47 per cent.*	*1.62 per cent.*

HYPERTROPHIC CASES		PROLIFERATIVE CASES
10.6 per cent.	Highest at start	10.6 per cent.
13.6 per cent.	Highest at end	12.9 per cent.
8.2 per cent.	Lowest at start	7.9 per cent.
9.4 per cent.	Lowest at end	10.4 per cent.
4.0 per cent.	Greatest rise	3.5 per cent.
0.7 per cent.	Smallest rise	0.2 per cent.
0	Greatest fall	0
0	Smallest fall	0

CHART 3

CYSTINE CONTENT OF THE FINGER NAILS IN 341 CASES

Change	No. of Cases	Per Cent.
Fall	65	19.06
Constant	11	3.23
Rise	265	77.71
	341	100.00

	Before	After	Increase
Average	9.85 per cent.	11.47 per cent.	1.62 per cent.
Sullivan and Hess [4]	9.77 per cent.	(In 103 cases of arthritis, without regard to type.)	

The greatest rise was 4.0 per cent. (8.30 per cent. to 12.30 per cent.).

DATA COLLECTED IN THIS STUDY

Pursuant of a definite policy of being hungry for information regarding arthritis, of having an open mind in regard to new methods of attack

CHART 4-A

CHANGES IN THE BLOOD CALCIUM IN TWENTY-FIVE CASES OF THE HYPERTROPHIC TYPE

Case No.	Before	After	Change
	Milligrams per 100 cubic centimeters of blood		
Cases in Which a Rise Was Shown (15 Cases).			
1	8.6	9.8	1.2
2	9.5	12.5	3.0
4	10.4	13.5	3.1
6	10.7	11.9	1.2
8	10.1	11.1	1.0
10	10.3	10.4	0.1
11	7.6	11.0	3.4
13	9.5	10.3	0.8
17	9.5	10.3	0.8
19	10.8	11.3	0.5
20	8.6	11.0	2.4
21	10.3	11.4	1.1
23	10.1	10.9	0.8
24	9.0	11.6	2.6
25	9.1	12.5	3.4
	144.1	169.5	25.4
Cases That Remained Constant (3 Cases).			
3	10.0	10.0	0.0
7	10.0	10.0	0.0
15	10.0	10.0	0.0
	30.0	30.0	0.0
Cases in Which a Fall Was Shown (7 Cases).			
5	10.6	10.0	0.6
9	10.1	8.4	1.7
12	11.3	10.1	1.2
14	13.7	8.9	4.8
16	13.6	9.0	4.6
18	11.3	11.1	0.2
22	10.1	9.4	0.7
	80.7	66.9	13.8
TOTAL	254.8	266.4	+11.6
AVERAGE	10.2	10.7	+ 0.5

and treatment, as was shown in previous papers [1, 2], but being very desirous of securing full information about these new methods before drawing conclusions about them, a series of cases was set aside for exhaustive study. In this connection fifty consecutive cases—twenty-five with hypertrophic

CHART 4-B

CHANGES IN THE BLOOD CALCIUM IN TWENTY-FIVE CASES OF THE PROLIFERATIVE TYPE

Case No.	Before	After	Change
	Milligrams per 100 cubic centimeters of blood		
Cases in Which a Rise Was Shown (8 Cases).			
4	10.5	11.2	0.7
5	9.0	11.6	2.6
9	9.8	10.2	0.4
12	7.9	10.1	2.2
13	11.0	11.6	0.6
14	11.0	11.2	0.2
18	9.8	10.4	0.6
22	10.5	11.4	0.9
	79.5	87.7	8.2
Cases That Remained Constant (5 Cases).			
2	8.8	8.8	0.0
8	11.0	11.0	0.0
15	10.5	10.5	0.0
19	11.4	11.4	0.0
23	9.2	9.2	0.0
	50.9	50.9	0.0
Cases in Which a Fall Was Shown (12 Cases).			
1	11.0	9.9	1.1
3	11.9	10.0	1.9
6	10.8	9.6	1.2
7	10.8	9.8	1.0
10	12.2	11.0	1.2
11	10.4	9.2	1.2
16	10.6	9.2	1.4
17	12.2	11.2	1.0
20	10.6	10.0	0.6
21	10.8	10.0	0.8
24	11.0	9.9	1.1
25	11.9	10.6	1.3
	134.2	120.4	13.8
TOTAL	264.6	259.0	−5.6
AVERAGE	10.6	10.4	−0.2

arthritis and twenty-five with proliferative arthritis (only the cases in which the type was so pure as to be beyond question were used)—which had failed to respond to the usual treatment over a reasonable length of time were chosen. (By the usual treatment is meant removal of foci, attention to general condition, correction of deformity, improvement of body mechanics, proper mechanical support, supervision of proper exercise and exercises, local applications, institution of adequate elimination, control of diet, use of indicated vaccine, selection of medication, etc.) In this way it was felt that the group became its own control,—in other words here was a group with certain findings (clinical and laboratory) after treatment in the usual accepted manner and in which any change in these findings could be reasonably attributed to any change in treatment (in this case the administration of sulphur). The same amount of sulphur (forty injections intravenously and forty injections intragluteally) was given each patient over the same length of time (three injections intravenously and three injections intragluteally each week, with complete study at the end of each series of ten intravenous and ten intragluteal injections). In other words, each case of this series had a complete work-up five times during the study, and it may be stated here that the findings at the intermediate periods were not bizarre. The variations in observations from before the experiment to after treatment were for the most part consistent and gradual. The observations are recorded in Charts 1-A and 1-B.

Before dissecting the findings in Charts 1-A and 1-B, it will be well to consider the clinical findings after the administration of sulphur. The subjective symptoms considered were pain on activity, pain without ac-

CHART 4-C

Analysis of Blood-Calcium Determinations

	Start	Finish	Change	No. Rising	No. Constant	No. Falling
	Milligrams per 100 cubic centimeters of blood					
Hypertrophic	10.2	10.7	0.5 (Rise)	15.0	3.0	7.0
Proliferative	10.6	10.4	0.2 (Fall)	8.0	5.0	12.0
Average	10.4	10.55	0.15 (Rise)	11.5	4.0	9.5

Hypertrophic		Proliferative
13.7 milligrams	Highest at start	12.2 milligrams
13.5 milligrams	Highest at end	11.6 milligrams
7.6 milligrams	Lowest at start	7.9 milligrams
8.4 milligrams	Lowest at end	8.8 milligrams
3.4 milligrams	Greatest rise	2.6 milligrams
0.1 milligrams	Smallest rise	0.2 milligrams
4.8 milligrams	Greatest fall	1.9 milligrams
0.2 milligrams	Smallest fall	0.6 milligrams

tivity, tenderness to pressure, occupational activity, emotional stability, appetite, ability to sleep well, and sense of general well-being. The objective signs used were deformity, size of joints, local heat, range of motions, crepitus, condition of circulation, tone of muscles, and condition of

CHART 5-A

CHANGES IN THE BLOOD SUGAR IN TWENTY-FIVE CASES OF THE HYPERTROPHIC TYPE

Case No.	Before	After	Change
	Milligrams per 100 cubic centimeters of blood		
Cases in Which a Rise Was Shown (11 Cases).			
6	82.	100.	18.
7	150.	155.	5.
11	110.	125.	15.
12	90.	100.	10.
13	80.	95.	15.
14	95.	105.	10.
16	90.	110.	20.
17	80.	95.	15.
18	92.	100.	8.
19	85.	100.	15.
20	120.	125.	5.
	1074.	1210.	136.
Cases That Remained Constant (3 Cases).			
3	100.	100.	0
4	85.	85.	0
24	90.	90.	0
	275.	275.	0
Cases in Which a Fall Was Shown (11 Cases).			
1	135.	105.	30.
2	100.	90.	10.
5	115.	110.	5.
8	150.	120.	30.
9	105.	100.	5.
10	140.	85.	55.
15	130.	125.	5.
21	95.	85.	10.
22	105.	100.	5.
23	105.	100.	5.
25	100.	90.	10.
	1280.	1110.	170.
TOTAL	2629.0	2595.0	−34.0
AVERAGE	105.2	103.8	− 1.4

tegmentum. The arthritis was so generalized in all the cases of this series that no classification of the joints involved is practical.

Taking the above as criteria, it can be said that every case improved subjectively in spite of the fact that all the cases were chosen because, up

CHART 5-B

CHANGES IN THE BLOOD SUGAR IN TWENTY-FIVE CASES OF THE PROLIFERATIVE TYPE

Case No.	Before	After	Change
Cases in Which a Rise Was Shown (4 Cases).			
	Milligrams per 100 cubic centimeters of blood		
3	100.	110.	10.
4	85.	117.	32.
22	85.	107.	22.
25	100.	110.	10.
	370.	444.	74.
Cases That Remained Constant (11 Cases).			
2	70.	70.	0.
5	90.	90.	0.
8	100.	100.	0.
11	75.	75.	0.
12	80.	80.	0.
13	80.	80.	0.
14	80.	80.	0.
15	80.	80.	0.
16	75.	75.	0.
19	100.	100.	0.
23	70.	70.	0.
	900.	900.	0.
Cases That Showed a Fall (10 Cases).			
1	105.	85.	20.
6	190.	110.	80.
7	115.	80.	35.
9	100.	95.	5.
10	95.	75.	20.
17	95.	90.	5.
18	100.	95.	5.
20	105.	95.	10.
21	120.	110.	10.
24	105.	85.	20.
	1130.	920.	210.
TOTAL	2400.0	2264.0	−136.0
AVERAGE	96.0	90.6	− 5.4

CHART 5-C

ANALYSIS OF BLOOD-SUGAR DETERMINATIONS

	Start	Finish	Change	No. Gaining	No. Constant	No. Losing
	Milligrams per 100 cubic centimeters of blood					
Hypertrophic	105.2	103.8	1.4 (Fall)	11.0	3.0	11.0
Proliferative	96.0	90.6	5.4 (Fall)	4.0	11.0	10.0
Average	100.6	97.2	3.4 (Fall)	7.5	7.0	10.5
Normal	80.0 to 120.0					

Hypertrophic Cases		Proliferative Cases
150 milligrams	Highest at start	190 milligrams
155 milligrams	Highest at end	117 milligrams
80 milligrams	Lowest at start	70 milligrams
85 milligrams	Lowest at end	70 milligrams
20 milligrams	Greatest rise	32 milligrams
5 milligrams	Smallest rise	10 milligrams
55 milligrams	Greatest fall	80 milligrams
5 milligrams	Smallest fall	5 milligrams

until that time, they had not improved under the usual accepted treatment. No patient expressed any desire to discontinue the treatment because of discouragement, and at the end of the experiment practically every patient asked that this medication be continued because of the improvement he or she felt had already been gained.

Considering the objective signs, improvement was not accepted unless it was definite. No gradations were made because it was felt that if any improvement could be gained by the amount of treatment given, greater improvement could be gotten by more. Deformity and range of motion can be taken together. Patients stated that they had a sensation of "falling apart" of the joints. It was found that contracted muscles and tendons could be stretched out more easily and with less effort and pain (85 per cent.), and that motion in joints (not always every joint of each individual) increased (in 100 per cent. of the cases). The spines in some (three) cases of arthritis deformans showed appreciable motion. Only a few of the cases had very much local heat (7 per cent.). None of the cases, however, had any local heat at the end of the experiment. The joints became smaller in size (65 per cent.). This was true mainly in cases of the proliferative type, for it was not found that definite hypertrophic bony changes (for example, Heberden's nodes) were affected at all, although the hypertrophic joints, especially the knees, showed smaller measurements, probably because of the shrinking of the periarticular tissues and possibly due to the reduction in amount of synovial fluid. The crepitus became less in about half the cases, but in no case did it disappear completely. Every case showed improvement in the circulation. This may be explained in two

CHART 6-A

Changes in Metabolism in Twenty-Five Cases of the Hypertrophic Type

Case No.	Before	After	Change
Cases in Which a Rise Was Shown (13 Cases).			
1	− 7	+ 5	12
3	−19	− 4	15
4	−31	−11	20
5	−21	−12	9
6	−19	−17	2
7	− 3	+ 5	8
9	− 3	+ 3	6
11	+29	+30	1
13	−18	− 4	14
17	−18	− 4	14
19	−17	−16	1
21	− 2	+ 5	7
24	− 4	+ 3	7
	−133	−17	+116
Cases That Remained Constant (3 Cases).			
10	− 5	− 5	0
15	− 6	− 6	0
22	− 5	− 5	0
	−16	−16	0
Cases in Which a Fall Was Shown (9 Cases).			
2	+ 9	+ 1	8
8	+ 5	− 6	11
12	−10	−15	5
14	− 8	−13	5
16	− 8	−10	2
18	−10	−15	5
20	+29	+10	19
23	+ 6	− 5	11
25	+ 9	+ 1	8
	+22	−52	−74
TOTAL	−127 0	−85 0	+42 0
AVERAGE	− 5.1	− 3.4	+ 1.7

ways: by the improvement of cardiac efficiency and by the improvement in detoxification. The tone of muscles improved (50 per cent.). The condition of the hair, skin, and nails improved in all cases. (In this connection an odd event occurred in that the snowy white hair of a female

CHART 6-B

Changes in Metabolism in Twenty-Five Cases of the Proliferative Type

Case No.	Before	After	Change
Cases in Which a Rise Was Shown (13 Cases).			
1	− 7	− 4	3
2	− 9	− 5	4
3	− 1	+ 9	10
4	− 38	− 9	29
6	− 30	−11	19
9	− 9	− 4	5
10	− 3	+ 2	5
13	− 5	+ 5	10
15	− 16	− 7	9
17	− 3	+ 4	7
18	− 7	− 4	3
21	− 11	− 3	8
23	− 9	− 5	4
	−148	−32	+116
Cases That Remained Constant (3 Cases).			
14	− 6	− 6	0
19	− 4	− 4	0
24	− 4	− 4	0
	− 14	−14	0
Cases in Which a Fall Was Shown (9 Cases).			
5	+ 3	− 4	7
7	+ 15	+ 5	10
8	+ 12	+ 5	7
11	+ 6	− 7	13
12	− 9	−15	6
16	+ 6	− 7	13
20	+ 10	+ 5	5
22	− 9	−29	20
25	+ 9	− 1	10
	+ 43	−48	−91
Total	−119.0	−94.0	+25.0
Average	− 4.8	− 3.8	+ 1.0

began to grow out black immediately after the administration of sulphur.) The hair became softer and less brittle. (An actual increase in amount was noted in a few cases.) The skin became pleasant to touch and lost its harsh and dry or sticky and clammy feeling. The nails (finger and toe) lost

CHART 6-C

Analysis of Metabolism Determinations

	Start	Finish	Change	No. Gaining	No. Constant	No. Losing
Hypertrophic	−5.1	−3.4	1.7 (Rise)	13	3	9
Proliferative	−4.8	−3.8	1.0 (Rise)	13	3	9
Average	−4.95	−3.6	1.35 (Rise)	13	3	9

Hypertrophic Cases		Proliferative Cases
+29	Highest at start	+15
+30	Highest at end	+ 9
−31	Lowest at start	−38
−17	Lowest at end	−29
20	Greatest rise	29
1	Smallest rise	3
19	Greatest fall	20
2	Smallest fall	5

some if not all of their dryness, brittleness, and irregularities. Sullivan and Hess[4] felt that, as the arthritic patient improved, the cystine content of his finger nails increased. If this is true, it may be that the improvement noted can be substantiated, for from Charts 2-A, 2-B, and 2-C it will be seen that every case of the series showed some increase (0.2 to 4.0 per cent.) in the cystine content of the finger nails.

It will be noted from Charts 2-A, 2-B, and 2-C that the cystine content of the finger nails after treatment of the cases with forty doses of sulphur (intravenous and intragluteal) reached an average of 11.45 per cent., which falls within the normal limits (11 to 13) set by Sullivan and Hess[4]. (In the determination of the cystine content of the finger nails in 697 cases, without respect to disease, an average of 11.06 per cent. was reached by the writer.) In 341 cases of arthritis (hypertrophic and proliferative) treated by the writer, apart from the fifty cases of the series shown in Charts 1-A and 1-B, the determination of the cystine content of the finger nails is analyzed in Chart 3.

It is interesting to note also that not only was a normal average obtained, but that this was not accomplished by a great rise in some cases and a lesser rise in others, but by each of the groups falling in the various levels of 5 to 6 per cent., 6 to 7 per cent., 7 to 8 per cent., 8 to 9 per cent., 9 to 10 per cent., and 10 to 11 per cent., rising by the proper amount to approach the normal 11 to 12 per cent. In other words, a case with a cystine content of 5 to 6 per cent. theoretically would have to rise about six points to reach normal, while one with a cystine content of 10 to 11 per cent. would have to rise one point only. This is just what occurred in the majority of the cases. The highest point reached was 16.2 per cent. Only 25 per cent. of the cases, starting with a cystine content below normal, failed to reach

CHART 7-A

CHANGES IN SEDIMENTATION IN TWENTY-FIVE CASES OF THE HYPERTROPHIC TYPE

Case No.	Before	After	Change
	Millimeters in 30 Minutes		
Cases in Which a Rise Was Shown (3 Cases).			
5	23	28	5
12	20	23	3
18	20	23	3
	63	74	11
Cases That Remained Constant (2 Cases).			
7	8	8	0
15	12	12	0
	20	20	0
Cases in Which a Fall Was Shown (20 Cases).			
1	17	8	9
2	30	12	18
3	32	6	26
4	25	16	9
6	38	12	26
8	33	12	21
9	20	8	12
10	24	6	18
11	23	9	14
13	37	12	25
14	37	18	19
16	31	14	17
17	37	35	2
19	35	8	27
20	38	9	29
21	27	12	15
22	21	12	9
23	33	11	22
24	43	29	14
25	32	18	14
	613	267	346
TOTAL	696.0	361.0	−335.0
AVERAGE	27.8	14.4	− 13.4

CHART 7-C

ANALYSIS OF SEDIMENTATION DETERMINATIONS

	Start	Finish	Change	No. Rising	No. Constant	No. Falling
	Millimeters in 30 Minutes					
HYPERTROPHIC	27.8	14.4	13.4 (Fall)	3.0	2.0	20.0
PROLIFERATIVE	22.1	11.1	11.0 (Fall)	1.0	5.0	19.0
AVERAGE	24.95	12.75	12.2 (Fall)	2.0	3.5	19.5
NORMAL	Below 20.00					

CHART 7-B

Changes in Sedimentation in Twenty-Five Cases of the Proliferative Type

Case No.	Before	After	Change
	Millimeters in 30 Minutes		
Cases in Which a Rise Was Shown (1 Case).			
10	4	6	2
	4	6	2
Cases That Remained Constant (5 Cases).			
6	6	6	0
9	10	10	0
16	7	7	0
17	18	18	0
21	6	6	0
	47	47	0
Cases in Which a Fall Was Shown (19 Cases).			
1	30	12	18
2	16	12	4
3	40	12	28
4	30	6	24
5	29	10	19
7	18	5	13
8	15	8	7
11	10	8	2
12	25	10	15
13	24	10	14
14	24	14	10
15	23	11	12
18	10	8	2
19	18	16	2
20	43	5	38
22	30	6	24
23	18	11	7
24	60	45	15
25	39	16	23
	502	225	277
TOTAL	553.0	275.0	−275.0
AVERAGE	22.1	11.1	− 11.0

CHART 7-C (*Continued*)

Hypertrophic Cases		Proliferative Cases
43	Highest at start	43
35	Highest at end	45
17	Lowest at start	4
6	Lowest at end	5
5	Greatest rise	2
3	Smallest rise	2
29	Greatest fall	38
2	Smallest fall	2

CHART 8-A

Changes in Indican in Twenty-Five Cases of the Hypertrophic Type

Case No.	Before	After	Change
Cases in Which a Rise Was Shown (17 Cases).			
1	0	+ 4	4
4	0	+ 2	2
5	0	+ 1	1
6	+1	+ 5	4
7	0	+ 3	3
8	0	+ 2	2
9	0	+ 4	4
10	0	+ 3	3
11	0	+ 5	5
13	0	+ 4	4
15	0	+ 3	3
17	0	+ 3	3
20	0	+ 5	5
21	0	+ 3	3
22	0	+ 4	4
23	0	+ 3	3
24	+1	+ 5	4
	+2	+59	57
Cases That Remained Constant (8 Cases).			
2	0	0	0
3	0	0	0
12	0	0	0
14	0	0	0
16	0	0	0
18	0	0	0
19	0	0	0
25	0	0	0
	0	0	0
Total	+2	+59	+57
Average	0.12	3.47	3.35

CHART 8-C

Analysis of Indican Determinations

	Start	Finish	Change	No. Rising	No. Constant	No. Falling
Hypertrophic	0.120	3.470	3.350 (Rise)	17	8	0
Proliferative	0.090	3.850	3.760 (Rise)	21	4	0
Average	0.105	3.660	3.555 (Rise)	19	6	0

CHART 8-B

CHANGES IN INDICAN IN TWENTY-FIVE CASES OF THE PROLIFERATIVE TYPE

Case No.	Before	After	Change
Cases in Which a Rise Was Shown (21 Cases).			
1	+1	+ 3	2
2	0	+ 1	1
3	0	+ 6	6
5	+1	+ 5	4
6	0	+ 2	2
7	0	+ 5	5
8	0	+ 4	4
9	0	+ 2	2
10	0	+ 5	5
12	0	+ 5	5
13	0	+ 5	5
14	0	+ 6	6
15	0	+ 5	5
17	0	+ 5	5
18	0	+ 2	2
19	0	+ 3	3
20	0	+ 5	5
21	0	+ 2	2
22	0	+ 2	2
24	0	+ 3	3
25	0	+ 5	5
	+2	+81	79
Cases That Remained Constant (4 Cases).			
4	0	0	0
11	0	0	0
16	0	0	0
23	0	0	0
	0	0	0
TOTAL	+2	+81	+79
AVERAGE	0.09	3.85	3.76

CHART 8-C (*Continued*)

HYPERTROPHIC		PROLIFERATIVE
+1	Highest at start	+1
+5	Highest at end	+6
0	Lowest at start	0
0	Lowest at end	0
+5	Greatest rise	+6
+1	Smallest rise	+1
0	Greatest fall	0
0	Smallest fall	0

CHART 9-A

CHANGES IN RED-BLOOD-CELL DETERMINATIONS IN TWENTY-FIVE CASES OF THE HYPERTROPHIC TYPE

Case No.	Before	After	Change
Cases in Which a Rise Was Shown (10 Cases).			
1	3,900,000	4,500,000	600,000
3	3,800,000	4,500,000	700,000
5	3,600,000	4,000,000	400,000
6	4,400,000	4,600,000	200,000
7	2,900,000	4,000,000	1,100,000
10	4,200,000	4,800,000	600,000
13	4,100,000	4,600,000	500,000
17	4,000,000	4,500,000	500,000
21	4,300,000	4,800,000	500,000
22	4,200,000	4,400,000	200,000
	39,400,000	44,700,000	5,300,000
Cases That Remained Constant (5 Cases).			
2	4,200,000	4,200,000	000,000
4	4,800,000	4,800,000	000,000
15	4,000,000	4,000,000	000,000
24	5,000,000	5,000,000	000,000
25	4,200,000	4,200,000	000,000
	22,200,000	22,200,000	000,000
Cases That Showed a Fall (10 Cases).			
8	4,600,000	4,000,000	600,000
9	4,200,000	3,900,000	300,000
11	4,800,000	4,100,000	700,000
12	5,400,000	4,100,000	1,300,000
14	4,400,000	4,300,000	100,000
16	4,400,000	4,300,000	100,000
18	5,400,000	4,600,000	800,000
19	4,700,000	4,000,000	700,000
20	4,800,000	4,600,000	200,000
23	4,600,000	4,000,000	600,000
	47,300,000	41,900,000	5,400,000
TOTAL	108,900,000	108,800,000	−100,000
AVERAGE	4,356,000	4,352,000	− 4,000

CHART 9-B

CHANGES IN RED-BLOOD-CELL DETERMINATIONS IN TWENTY-FIVE CASES OF THE PROLIFERATIVE TYPE

Case No.	Before	After	Change
Cases in Which a Rise Was Shown (12 Cases).			
1	3,400,000	4,700,000	1,300,000
6	3,900,000	4,700,000	800,000
7	3,900,000	4,000,000	100,000
8	4,300,000	4,600,000	300,000
9	4,600,000	4,800,000	200,000
11	3,900,000	4,200,000	300,000
13	4,400,000	4,600,000	200,000
16	4,000,000	4,800,000	800,000
20	4,500,000	4,600,000	100,000
21	3,900,000	4,700,000	800,000
23	4,800,000	4,900,000	100,000
24	3,700,000	4,700,000	1,000,000
	49,300,000	55,300,000	6,000,000
Cases That Remained Constant (11 Cases).			
3	4,600,000	4,600,000	000,000
4	4,500,000	4,500,000	000,000
10	4,400,000	4,400,000	000,000
12	4,400,000	4,400,000	000,000
14	4,400,000	4,400,000	000,000
15	4,800,000	4,800,000	000,000
17	4,400,000	4,400,000	000,000
18	4,800,000	4,800,000	000,000
19	4,600,000	4,600,000	000,000
22	4,500,000	4,500,000	000,000
25	4,700,000	4,700,000	000,000
	50,100,000	50,100,000	000,000
Cases That Showed a Fall (2 Cases).			
2	4,500,000	4,400,000	100,000
5	5,000,000	4,400,000	600,000
	9,500,000	8,800,000	700,000
TOTAL	108,900,000	114,200,000	+5,300,000
AVERAGE	4,356,000	4,568,000	212,000

CHART 9-C

ANALYSIS OF RED-BLOOD-CELL DETERMINATIONS

	Start	Finish	Change	No. Rising	No. Constant	No. Falling
HYPERTROPHIC	4,356,000	4,352,000	4,000 (Fall)	10	5	10
PROLIFERATIVE	4,356,000	4,568,000	212,000 (Rise)	12	11	2
AVERAGE	4,356,000	4,460,000	104,000 (Rise)	11	8	6
NORMAL	5,000,000					

HYPERTROPHIC		PROLIFERATIVE
5,400,000	Highest at start	5,000,000
5,000,000	Highest at end	4,900,000
2,900,000	Lowest at start	3,100,000
3,900,000	Lowest at end	4,000,000
1,100,000	Greatest rise	1,300,000
200,000	Smallest rise	100,000
1,300,000	Greatest fall	600,000
100,000	Smallest fall	100,000

normal during the treatment. In the special series of fifty cases, no case fell in cystine content and none stayed constant. There was a rise in all cases.

For the determination of the cystine content, the nails were cleaned first with polish remover, if the patient used nail polish. The nails were then thoroughly brushed and cleaned with an orange stick. They were trimmed as closely as they could be trimmed in order to obtain as much nail as possible and to leave as little to fall from one growth period into the next. Sulphur was not started before the initial cystine-content determination in any case, nor was time allowed to elapse in order that the nails might grow before the sulphur was started. The method of determination used was that of Neale and Peabody[11], developed for the writer especially for the examination of finger nails for the present investigation. It has proved practical, and at the same time the results seem to substantiate Sullivan's[4] conclusions.

A chemical laboratory with a thoroughly trained biochemist is necessary. As was stated in Part I of this paper[1], it is not enough to study only the sulphur changes and their effect upon the clinical findings, but it is also necessary to observe the changes in various other physiological processes. This also has been done, and the observations are set down in the accompanying charts.

The changes in the blood calcium during treatment with sulphur, as shown in Charts 4-A, 4-B, and 4-C, were not significant. The only change was an average rise of 0.15 milligrams per 100 cubic centimeters of blood, which would easily have been a normal fluctuation (normal blood calcium: 9 to 13 milligrams per 100 cubic centimeters of blood). However, the cases low at the start increased the most, and those high at the start in-

CHART 10-A

Changes in White-Blood-Cell Determinations in Twenty-Five Cases of the Hypertrophic Type

Case No.	Before	After	Change
Cases in Which a Rise Was Shown (10 Cases).			
3	4,800	8,200	3,400
4	7,800	9,500	1,700
12	5,600	6,100	500
13	8,200	11,000	2,800
14	8,200	8,300	100
16	8,200	8,300	100
18	5,100	7,300	2,200
22	8,000	8,200	200
23	6,800	7,000	200
24	8,600	9,000	400
	71,300	82,900	11,600
Cases That Remained Constant (2 Cases).			
2	7,000	7,000	000
25	7,000	7,000	000
	14,000	14,000	000
Cases in Which a Fall Was Shown (13 Cases).			
1	8,000	6,200	1,800
5	8,000	6,600	1,400
6	8,800	6,300	2,500
7	5,400	4,900	500
8	6,800	6,100	700
9	8,000	6,300	1,700
10	8,500	7,900	600
11	8,500	7,600	900
15	5,500	5,000	500
17	8,200	7,500	700
19	8,800	8,100	700
20	8,500	7,600	900
21	8,500	8,200	300
	101,500	88,300	13,200
Total	186,800	185,200	−1,600
Average	7,492	7,408	− 64

creased the least. This only raises the question as to whether the administration of sulphur might serve as a stabilizer of the blood calcium.

The blood-sugar determinations (Charts 5-A, 5-B, and 5-C) reveal an average fall of 3.4 milligrams. In the light of the wide normal fluctuation (80 to 120 milligrams per 100 cubic centimeters of blood) this may bear no

CHART 10-B

Changes in White-Blood-Cell Determinations in Twenty-Five Cases of the Proliferative Type

Case No.	Before	After	Change
Cases in Which a Rise Was Shown (7 Cases).			
4	6,400	7,200	800
5	8,600	9,000	400
7	5,600	9,900	4,300
11	6,800	7,000	200
16	7,000	7,200	200
18	8,000	8,200	200
22	6,600	7,200	600
	49,000	55,700	6,700
Cases That Remained Constant (2 Cases).			
8	6,200	6,200	000
19	7,800	7,800	000
	14,000	14,000	000
Cases in Which a Fall Was Shown (16 Cases).			
1	10,400	6,600	3,800
2	8,800	8,000	800
3	8,700	5,100	3,600
6	8,400	4,900	3,500
9	8,200	8,000	200
10	10,600	8,600	2,000
12	10,600	7,000	3,600
13	7,400	6,700	700
14	7,400	6,700	700
15	8,200	8,000	200
17	8,600	8,400	200
20	11,200	9,500	1,700
21	8,400	7,900	500
23	8,000	7,900	100
24	8,800	7,900	900
25	8,900	5,300	3,600
	142,600	116,500	26,100
Total	205,600	186,200	−19,400
Average	8,224	7,448	− 776

weight, but a rather high blood sugar (150 to 190 milligrams) was noted in several cases in which the urine was negative, and in all of the cases showing over 120 milligrams there was a decided approach to normal with the exception of one case, that rising from 150 to 155.

As shown in Charts 6-A, 6-B, and 6-C, there was an average rise in

CHART 10-C

ANALYSIS OF WHITE-BLOOD-CELL DETERMINATIONS

	Start	Finish	Change	No. Rising	No. Constant	No. Falling
HYPERTROPHIC	7472	7408	64 (Fall)	10.0	2.0	13.0
PROLIFERATIVE	8224	7448	776 (Fall)	7.0	2.0	16.0
AVERAGE	7848	7428	420 (Fall)	8.5	2.0	14.5
NORMAL	8000					

HYPERTROPHIC		PROLIFERATIVE
8,800	Highest at start	11,200
11,000	Highest at end	9,900
4,800	Lowest at start	5,600
4,900	Lowest at end	4,900
3,400	Greatest rise	4,300
100	Smallest rise	200
2,500	Greatest fall	3,800
300	Smallest fall	100

the metabolic rate of 1.35. This figure is not indicative of the true amount of improvement, however. The cases with rather low metabolic rates seemed to do the worst ordinarily, and it seemed to be in the cases with the lower metabolic rates that the rate was raised the most, and it also seemed to be these same cases that were clinically improved the most.

In Charts 7-A, 7-B and 7-C we have a very significant observation. There was an average fall in the sedimentation rate of 12.2 (determinations taken to thirty minutes[14]). Thirty-nine out of fifty cases (78 per cent.) fell, and only four out of fifty (8 per cent.) rose. Only one case rose to what would be considered marked limits (23 to 28), and every case that started in the upper brackets fell to normal (below 20) except three (60 to 45, 37 to 35, 43 to 29). It will be remembered that so far as possible all demonstrable foci had been removed previous to the sulphur treatment, with no effect upon the sedimentation rate.

Charts 8-A, 8-B, and 8-C indicate that there was an average rise of 3.56 in the indican. Thirty-eight cases (76 per cent.) gained and no case lost. Of the fifty cases only four showed indican in the urine before treatment, and these only to the extent of plus one (+1). It was noted that the patient's subjective symptoms, or sense of well-being, were almost always in proportion to the amount of indican found in the urine. It was often amusing to examine the urine before seeing the patient and to be able to predict the patient's reply to a query as to the state of his health. It has been noted that this seems true in the whole series (892 cases) of arthritis considered and would bear up the theory that the treatment by sulphur assists in detoxifying the patient [12].

The red-blood-cell determinations indicated an average rise of 104,000 red blood cells, which is of no significance (Chart 9-C).

CHART 11-A

CHANGES IN HEMOGLOBIN IN TWENTY-FIVE CASES OF THE HYPERTROPHIC TYPE

Case No.	Before	After	Change
Cases in Which a Rise Was Shown (6 Cases).			
2	80	85	5
4	65	95	30
6	70	75	5
13	90	95	5
17	90	95	5
19	70	75	5
	465	520	55
Cases That Remained Constant (5 Cases).			
1	90	90	0
3	80	80	0
8	85	85	0
23	85	85	0
25	80	80	0
	420	420	0
Cases in Which a Fall Was Shown (14 Cases).			
5	80	75	5
7	80	60	20
9	80	75	5
10	90	85	5
11	90	85	5
12	90	80	10
14	90	80	10
15	80	79	1
16	90	80	10
18	90	80	10
20	90	85	5
21	90	85	5
22	80	75	5
24	90	85	5
	1210	1109	101
TOTAL	2095.0	2049.0	−46.0
AVERAGE	83.8	82.0	− 1.8

CHART 11-C

ANALYSIS OF HEMOGLOBIN DETERMINATIONS

	Start	Finish	Change	No. Rising	No. Constant	No. Falling
HYPERTROPHIC	83.8	82.0	1.8 (Fall)	6.0	5.0	14.0
PROLIFERATIVE	80.4	81.0	0.6 (Rise)	7.0	7.0	11.0
AVERAGE	82.1	81.5	0.6 (Fall)	6.5	6.0	12.5

CHART 11-B

Changes in Hemoglobin in Twenty-Five Cases of the Proliferative Type

Cases in Which a Rise Was Shown (7 Cases).

Case No.	Before	After	Change
1	60	70	10
6	80	95	15
11	55	65	10
16	55	85	30
20	80	85	5
21	80	95	15
24	65	75	10
	475	570	95

Cases That Remained Constant (7 Cases).

Case No.	Before	After	Change
8	80	80	0
9	85	85	0
10	90	90	0
12	85	85	0
15	85	85	0
17	90	90	0
19	80	80	0
	595	595	0

Cases in Which a Fall Was Shown (11 Cases).

Case No.	Before	After	Change
2	85	80	5
3	85	75	10
4	85	80	5
5	90	85	5
7	80	75	5
13	90	70	20
14	85	80	5
18	85	80	5
22	85	80	5
23	85	80	5
25	85	75	10
	940	860	80
Total	2010.0	2025.0	+15.0
Average	80.4	81.0	+ 0.6

CHART 11-C (*Continued*)

Hypertrophic		Proliferative
90	Highest at start	90
95	Highest at end	95
55	Lowest at start	65
65	Lowest at end	60
30	Greatest rise	30
5	Smallest rise	5
20	Greatest fall	20
5	Smallest fall	1

CHART 12-A

Changes in Blood-Pressure and Pulse-Pressure Determinations Twenty-Five Cases of the Hypertrophic Type

Case No.	Before			After			Change		
	SP	DP	PP	SP	DP	PP	SP	DP	PP
3	120	80	40	130	80	50	+10	0	+10
13	110	60	50	140	90	50	+30	+30	0
17	110	60	50	140	90	50	+30	+30	0
18	148	90	58	165	82	83	+17	− 8.	+25
20	150	90	60	155	85	70	+ 5	− 5	+10
5 Cases	638	380	258	730	427	303	+92	+47	+45
Average	127.6	76.0	51.6	146.0	85.4	60.6	+18.4	+ 9.4	+ 9
2	150	70	80	150	100	50	0	+30	−30
5	120	80	40	120	80	40	0	0	0
8	155	90	65	155	90	65	0	0	0
15	155	85	70	155	85	70	0	0	0
23	155	90	65	155	90	65	0	0	0
5 Cases	735	415	320	735	445	290	0	+30	−30
Average	147.	83.	64.	147.	89.	58.	0	+ 6	− 6
1	160	90	70	130	90	40	−30	0	−30
4	200	110	90	170	100	70	−30	−10	−20
6	178	84	94	140	80	60	−38	− 4	−34
7	150	85	65	140	80	60	−10	− 5	− 5
9	182	130	52	150	95	55	−32	−35	+ 3
10	148	86	62	130	80	50	−18	− 6	−12
11	150	90	60	140	80	60	−10	−10	0
12	148	90	58	130	70	60	−18	−20	+ 2
14	135	95	40	110	70	40	−25	−25	0
16	145	75	70	115	70	45	−30	− 5	−25
19	178	84	94	140	80	60	−38	− 4	−34
21	146	80	66	140	80	60	− 6	0	− 6
22	175	95	80	150	95	55	−25	0	−25
24	160	95	65	150	95	55	−10	0	−10
25	155	70	85	150	100	50	− 5	+30	−35
15 Cases	2410	1359	1051	2085	1265	820	−325	−94	−231
Average	160.67	90.6	70.07	139.	84.33	54.67	21.67	6.27	15.4
Grand Total 25 Cases	3783	2154	1629	3550	2137	1413	−233	−17	−216
Average	151.3	86.16	65.16	142.00	85.48	56.52	− 9.32	− 0.68	− 9.64

CHART 12-C

Analysis of Systolic-Pressure Determinations

	Start	Finish	Change	No. Rising	No. Constant	No. Falling
Hypertrophic	151.3	142.0	9.32 (Fall)	5	5	15
Proliferative	124.7	123.0	1.70 (Fall)	5	7	13
Average	138.0	132.5	5.5 (Fall)	5	6	14

Hypertrophic		Proliferative
200	Highest at start	160
170	Highest at end	145
110	Lowest at start	110
110	Lowest at end	105
30	Greatest rise	35
5	Smallest rise	2
38	Greatest fall	25
5	Smallest fall	2

CHART 12-B

Changes in Blood-Pressure and Pulse-Pressure Determinations
Twenty-Five Cases of the Proliferative Type

Case No.	Before			After			Change		
	SP	DP	PP	SP	DP	PP	SP	DP	PP
3	118	86	32	120	80	40	+2	−6	+8
6	110	80	30	120	80	40	+10	0	+10
13	170	70	40	145	85	60	+35	+15	+20
14	110	70	40	145	85	60	+35	+15	+20
22	120	80	40	130	90	40	+10	+10	0
5 Cases	568	386	182	660	420	240	+92	+34	+58
Average	114	77	37	132	84	48	+18	+6	+12
4	120	80	40	120	80	40	0	0	0
7	120	80	40	120	80	40	0	0	0
8	120	80	40	120	80	40	0	0	0
9	120	80	40	120	80	40	0	0	0
20	120	80	40	120	80	40	0	0	0
21	110	80	30	110	80	30	0	0	0
23	130	70	60	130	70	60	0	0	0
7 Cases	840	550	290	840	550	290	0	0	0
Average	120	79	41	120	79	41	0	0	0
1	118	72	46	110	75	35	−8	+3	−11
2	130	70	60	120	80	40	−10	+10	−20
5	160	75	85	140	80	60	−20	+5	−25
10	145	70	75	120	80	40	−25	+10	−35
11	110	50	60	105	60	45	−5	+10	−15
12	126	60	66	120	80	40	−6	+20	−26
15	126	60	66	120	80	40	−6	+20	−26
16	130	50	80	120	80	40	−10	+30	−40
17	145	70	75	120	80	40	−25	+10	−35
18	130	80	50	125	80	45	−5	0	−5
19	150	90	60	140	90	50	−10	0	−10
24	120	70	50	118	72	46	−2	+2	−4
25	120	70	50	118	86	32	−2	+16	−18
13 Cases	1710	887	823	1576	1023	553	−134	+136	−270
Average	131.5	68.2	63.3	121.2	78.7	42.5	−10.3	+10.5	−20.8
Grand Total 25 Cases	3118	1823	1295	3076	1993	1083	−42	+170	−212
Average	124.7	72.9	51.8	123.0	79.7	43.3	−1.7	+6.8	−8.5

CHART 12-D

Analysis of Pulse-Pressure Determinations

	Start	Finish	Change	No. Rising	No. Constant	No. Falling
Hypertrophic	65.16	56.52	8.64 (Fall)	5.0	8.0	12.0
Proliferative	51.80	43.30	8.50 (Fall)	4.0	8.0	13.0
Average	58.48	49.91	8.57 (Fall)	4.5	8.0	12.5

Hypertrophic		Proliferative
94	Highest at start	85
83	Highest at end	60
40	Lowest at start	30
40	Lowest at end	30
25	Greatest rise	20
2	Smallest rise	8
35	Greatest fall	40
5	Smallest fall	4

In the light of investigations of the effect of drugs upon the white blood count[13], the average fall in the white blood count (420), while not to be desired, is too small to give alarm. However, Charts 10-A, 10-B, and 10-C do not substantiate the finding of Mackay[10], in that he

CHART 13-A

CHANGES IN WEIGHT DETERMINATIONS IN TWENTY-FIVE CASES OF THE HYPERTROPHIC TYPE

Case No.	Before	After	Change
Cases in Which a Rise Was Shown (7 Cases).			
5	149 pounds	150 pounds	1 pound
6	126 pounds	127 pounds	1 pound
12	118 pounds	120 pounds	2 pounds
14	127 pounds	128 pounds	1 pound
18	119 pounds	120 pounds	1 pound
22	152 pounds	157 pounds	5 pounds
24	150 pounds	156 pounds	6 pounds
	941 pounds	958 pounds	17 pounds
Cases That Remained Constant (4 Cases).			
1	138 pounds	138 pounds	0 pounds
11	160 pounds	160 pounds	0 pounds
17	155 pounds	155 pounds	0 pounds
20	160 pounds	160 pounds	0 pounds
	613 pounds	613 pounds	0 pounds
Cases in Which a Fall Was Shown (14 Cases).			
2	137 pounds	128 pounds	9 pounds
3	103 pounds	101 pounds	2 pounds
4	162 pounds	158 pounds	4 pounds
7	192 pounds	180 pounds	12 pounds
8	230 pounds	210 pounds	20 pounds
9	159 pounds	152 pounds	7 pounds
10	174 pounds	169 pounds	5 pounds
13	155 pounds	140 pounds	15 pounds
15	192 pounds	184 pounds	8 pounds
16	132 pounds	127 pounds	5 pounds
19	127 pounds	124 pounds	3 pounds
21	174 pounds	160 pounds	14 pounds
23	210 pounds	190 pounds	20 pounds
25	137 pounds	128 pounds	9 pounds
	2284 pounds	2151 pounds	133 pounds
TOTAL	3838.0 pounds	3722.0 pounds	−116.0 pounds
AVERAGE	153.5 pounds	148.9 pounds	− 4.6 pounds

reported a leukocytosis usually from 20,000 to 30,000. No such figures were found at any time during the period of this investigation (four to five months).

Charts 11-A, 11-B, and 11-C show the hemoglobin determinations.

CHART 13-B

CHANGES IN WEIGHT DETERMINATIONS IN TWENTY-FIVE CASES OF THE PROLIFERATIVE TYPE

Case No.	Before	After	Change
Cases in Which a Rise Was Shown (5 Cases).			
7	101 pounds	106 pounds	5 pounds
9	126 pounds	128 pounds	2 pounds
11	99 pounds	102 pounds	3 pounds
16	101 pounds	122 pounds	21 pounds
20	118 pounds	120 pounds	2 pounds
	545 pounds	578 pounds	33 pounds
Cases That Remained Constant (1 Case).			
19	126 pounds	126 pounds	0 pounds
	126 pounds	126 pounds	0 pounds
Cases in Which a Fall Was Shown (19 Cases).			
1	109 pounds	107 pounds	2 pounds
2	141 pounds	134 pounds	7 pounds
3	127 pounds	113 pounds	14 pounds
4	134 pounds	132 pounds	2 pounds
5	150 pounds	143 pounds	7 pounds
6	209 pounds	180 pounds	29 pounds
8	170 pounds	150 pounds	20 pounds
10	176 pounds	172 pounds	4 pounds
12	123 pounds	118 pounds	5 pounds
13	113 pounds	112 pounds	1 pound
14	113 pounds	112 pounds	1 pound
15	123 pounds	118 pounds	5 pounds
17	176 pounds	172 pounds	4 pounds
18	131 pounds	125 pounds	6 pounds
21	190 pounds	165 pounds	25 pounds
22	163 pounds	159 pounds	4 pounds
23	141 pounds	140 pounds	1 pound
24	109 pounds	106 pounds	3 pounds
25	127 pounds	109 pounds	18 pounds
	2725 pounds	2567 pounds	158 pounds
TOTAL	3396.0 pounds	3271.0 pounds	−125.0 pounds
AVERAGE	135.8 pounds	130.8 pounds	− 5.0 pounds

CHART 13-C

ANALYSIS OF WEIGHT DETERMINATIONS

	Start	Finish	Change	No. Rising	No. Constant	No. Falling
	Pounds	*Pounds*	*Pounds*			
HYPERTROPHIC	153.5	148.9	4.6 (Fall)	7.0	4.0	14.0
PROLIFERATIVE	135.8	130.8	5.0 (Fall)	5.0	1.0	19.0
AVERAGE	144.7	139.9	4.8 (Fall)	6.0	2.5	16.5

HYPERTROPHIC		PROLIFERATIVE
230 pounds	Highest at start	209 pounds
210 pounds	Highest at end	180 pounds
103 pounds	Lowest at start	99 pounds
101 pounds	Lowest at end	102 pounds
6 pounds	Greatest rise	21 pounds
1 pound	Smallest rise	2 pounds
20 pounds	Greatest fall	29 pounds
2 pounds	Smallest fall	1 pound

An average fall of even 0.6 in a series of cases in which the average was already at a low normal is not to be desired. However, in only nine cases did the hemoglobin fall below 80, and in only one of these did it fall below 70 (60). There was no evidence of a consistent marked fall in the hemoglobin, but in cases otherwise improving this fact has enough interest to warrant further working out of this point to bear out the original contention that the toxicological studies would not indicate that this preparation (colloidal sulphur) is harmful in clinical doses.

Generally speaking the blood pressure was high in the hypertrophic cases (average 151.3), and only slightly so in the proliferative cases (average 124.7), as shown in Charts 12-A, 12-B, 12-C, and 12-D. It is interesting, therefore, to note an average fall of 9.32 in the former, and 1.7 in the latter. This suggests again the stabilizing influence of the sulphur and its effect in vital activities [12].

The pulse pressure, quite high in both the hypertrophic (average 65.2) and proliferative (average 51.8) types, fell an almost equal amount in both hypertrophic (8.64) and proliferative (8.5), to give resultant pulse pressures of 56.5 in the former and 43.3 in the latter,—a decided approach to the accepted normal (40).

Charts 13-A, 13-B, and 13-C indicate that there was an average fall of 4.8 pounds in the weight of the patients in this series. In view of the fact that it was difficult to control the diet to the extent of effecting weight control, because of the social conditions of the patients, this fact would suggest that the administration of sulphur according to this method produces a certain degree of weight reduction.

No temperature changes of note were found following the sulphur injections. Some of the patients complained of feeling hot in the afternoon of the treatment day (injection having been given in the morning),

but only in a very few sporadic cases were we really able to demonstrate any temperature rise.

Roentgenographic studies were made of the left hand, the left knee, and the joint giving the most trouble in every case, and, while these studies were repeated every three months for a year, no increase in the progress of the disease was seen in any case.

SUMMARY

1. An explanation of part of the problem of arthritis may lie in the study of sulphur.
2. The intravenous and intragluteal administration of colloidal sulphur (Sulfur-Diasporal) is practically without reaction.
3. The study of fifty cases of arthritis (twenty-five of the hypertrophic type and twenty-five of the proliferative type), treated with colloidal sulphur (intravenous and intragluteal), seemed to indicate:
   - *a.* An apparent improvement in the subjective symptoms and objective signs.
   - *b.* An increase in the cystine content of the finger nails.
   - *c.* The possibility of some degree of stabilization of the blood calcium.
   - *d.* A small decrease in the blood sugar.
   - *e.* An average slight rise in the metabolic rate, with most improvement in those cases with low metabolic rates.
   - *f.* A fall in the sedimentation rate.
   - *g.* An increased appearance of indican in the urine.
   - *h.* No significant effect upon the red blood cells.
   - *i.* A slight fall in the white blood count.
   - *j.* A slight fall in the hemoglobin.
   - *k.* A fall in the blood pressure.
   - *l.* A fall in the pulse pressure.
   - *m.* A tendency to weight reduction.
   - *n.* No marked temperature changes.
   - *o.* An x-ray indication of no progress of the disease.
4. The study of 341 cases of arthritis (hypertrophic and proliferative) showed an average rise of 1.62 per cent. in the cystine content of the finger nails following treatment with colloidal sulphur.
5. The study of 892 cases of arthritis (hypertrophic and proliferative) indicated that improvement in the subjective symptoms and objective signs may be expected following treatment with colloidal sulphur.

The material, Sulfur-Diasporal, used in the investigation reported in these papers was donated through the courtesy of The Doak Company of Cleveland, Ohio.

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TREATMENT OF FRACTURED NECK OF THE FEMUR BY AXIAL FIXATION WITH STEEL WIRES * †

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In 1931, one of us, feeling that fractures of the neck of the femur were doomed to a relatively high percentage of non-union, conceived the idea of treating these fractures from their onset with this fact in mind. Why wait until non-union had occurred before using the very simple method of drilling to promote vascularization? In the first of these cases in 1932, following the drilling, the author allowed one of the Kirschner wires to remain in place as a means of fixation of the fragments. In the first cases, the wires were allowed to protrude through the skin and were protected by dressings. It was found, however, that in motion of the limb a local irritation of the skin about the wires ensued. Therefore, at the suggestion of Dr. Joseph Milgram, the wires were clipped as closely to the bone as possible. This was done by compressing the skin. The tissues were allowed to spring back into place, covering the cut ends of the wires. This method with slight modification has been followed since. The method in detail is as follows:

The site of fracture is anaesthetized by the introduction of ten to fifteen cubic centimeters of 2 per cent. novocain solution into the hematoma at the site of fracture. The needle is plunged from the anterior aspect of the groin directly posteriorly over the site of fracture. When blood can be aspirated, we know that we are at the fracture site. The fracture is then reduced by whatever means is habitually used by the surgeon. We, ourselves, are using the Leadbetter method. The procedure is carried out on the x-ray table and a film is then taken to determine the accuracy of the reposition of the fragments.

Not more than 20 degrees of abduction is usually necessary, but at least 20 degrees of internal rotation should be rigidly maintained. When the x-ray shows reposition to be accurate (and reposition *must* be accurate), measurements are taken on that film which enable the surgeon to ascertain the point of entrance, direction, and depth to which the wires are to be inserted (Fig. 1). The following are the measurements which we use:

A: Point of Entry. This is determined by drawing a line through the longitudinal axis of the neck and measuring the distance between the tip of the greater trochanter and the point where this line meets the lateral contour of the femur. This distance is usually between two and three inches.

* Presented before the Orthopaedic Section of the New York Academy of Medicine, May 1934, and read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, New York, N. Y., January 16, 1935.
† Received for publication December 20, 1934.

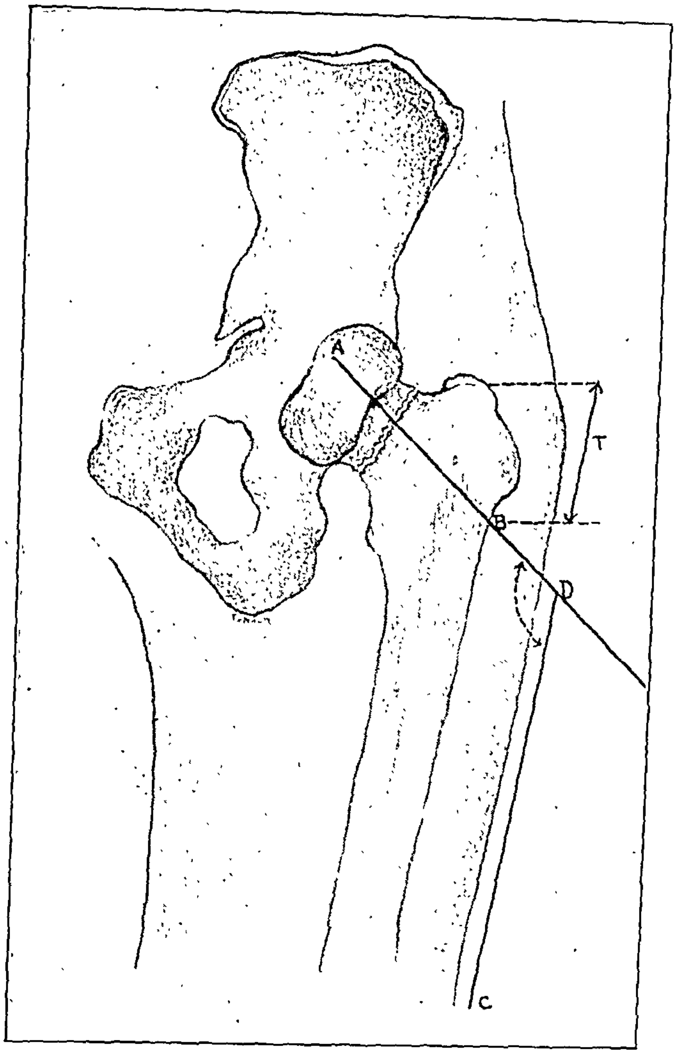

FIG. 1

Diagram showing the method of taking measurements for the insertion of the wires: *T*, distance from the tip of the trochanter to the point of entry; *AB*, depth of insertion; *ADC*, angle to determine direction of wire.

B: Direction. The direction of the wire is determined by measuring the angle made by this line with the lateral outline of the thigh.

C: Depth of Insertion. The depth to which it is necessary to bury the wire is determined by measuring the distance from the center of the head of the femur to the periphery of the shaft. The x-ray measurements are projections of the true measurements and are, therefore, inaccurate. Allowance should be made for this. The accurate measurement is determined as follows: For a tube distance of thirty inches, the distance from the tube to the hip is measured. This is usually found to be twenty-five inches. The formula used for determining the distortion which we have obtained in the roentgenogram is as follows: Tube to the film distance is to tube to the hip distance as film measurement is to actual measurement. If we take as an example that the tube to film distance is thirty inches, the tube to hip distance is twenty-five inches, and

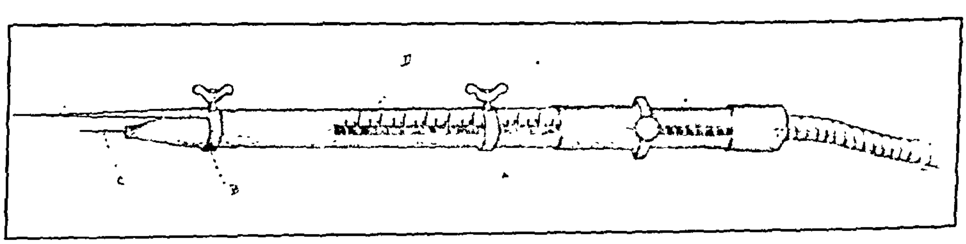

FIG. 2

Motor-driven drill: *A*, collar for predetermining distance to which pin may be inserted; *B*, prong collar for fixing instrument to femur; *C*, wire; *D*, scale.

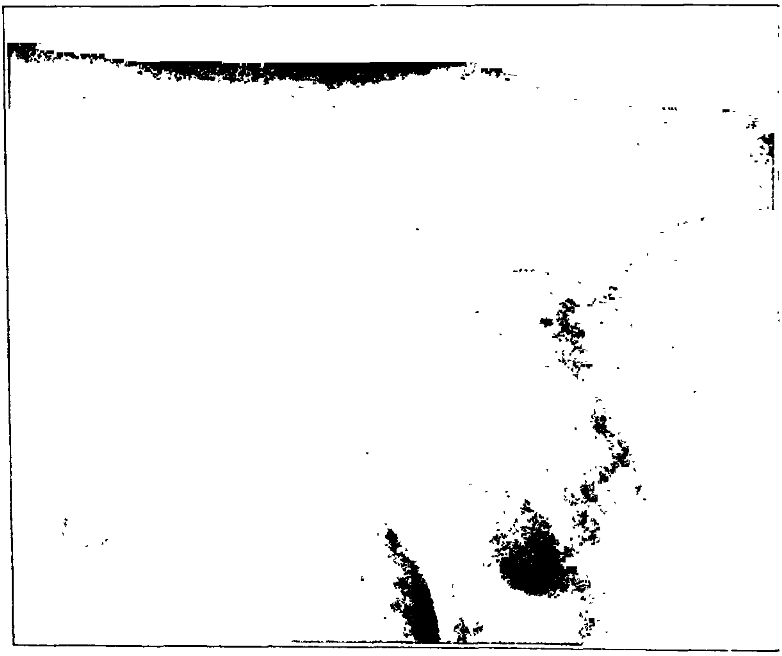

Fig. 3

Case 11. Before reduction.

Fig. 4

Case 11. After first reduction and wiring.

Fig. 5

Case 11. Roentgenograms of post-mortem specimen.

Fig. 6

Case 11. Photograph of post-mortem specimen.

the head to periphery measurement is four inches, the formula would be as follows:

$$30:25::4:x$$
$$30x=100$$
$$x=3.3 \text{ inches}$$

or the true depth to which the wire should be inserted.

We use the motor-driven drill (Fig. 2) to allow rapid and painless insertion of the wire. Skin anaesthesia is not necessary as the wire itself causes no more pain than the hypodermic needle. In order to control the length of the wire introduced, we have added a movable collar and a stabilizing prong to the apparatus. The prong is thrust through the tissues until it strikes the side of the femur. This makes the apparatus im-

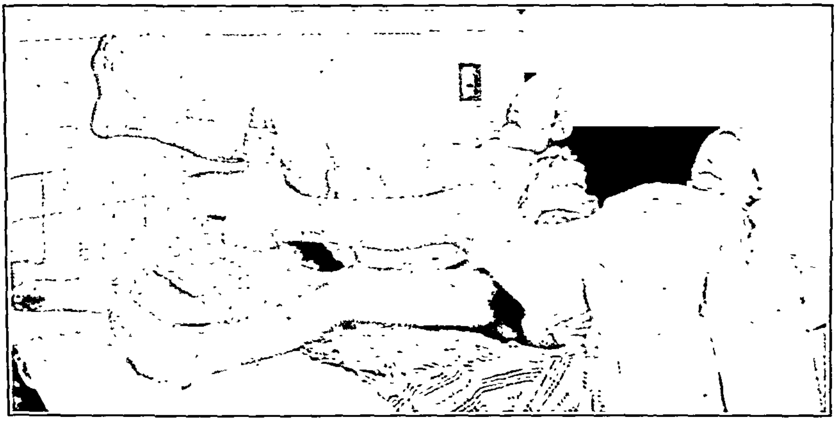

FIG. 7

Cases 2 and 3. Showing stability and motion of hips six weeks after the wires were inserted.

mobile and eliminates movement against the soft parts. The wire is then pushed through the skin until it strikes bone. Now the movable collar is locked at the predetermined distance on the scale. The angle having been carefully checked, the wire is rapidly thrust through the fragments. Another roentgenogram is taken and, if the first or guide wire is found to be in satisfactory position, the wire is allowed to remain in place. If it has entered too far, it is withdrawn to the desired distance. Two other wires are then passed at different angles in an attempt to have them cross each other, preferably within the capital fragment.* After the wires have been inserted, the resistance to external rotation, which has been tested during the Leadbetter manoeuver, is found to be tremendously increased. Another roentgenogram is taken and the wires may either be introduced

* In the last two cases of our series, drill rods, eight hundredths of an inch thick, have been used instead of Kirschner wires. These rods are threaded, eighty threads to the inch, for a distance of two inches from their tip. After they have been threaded, the rods are hardened to spring-steel temper. They are introduced by means of a Jacobs' chuck attached to the Albee electric motor.

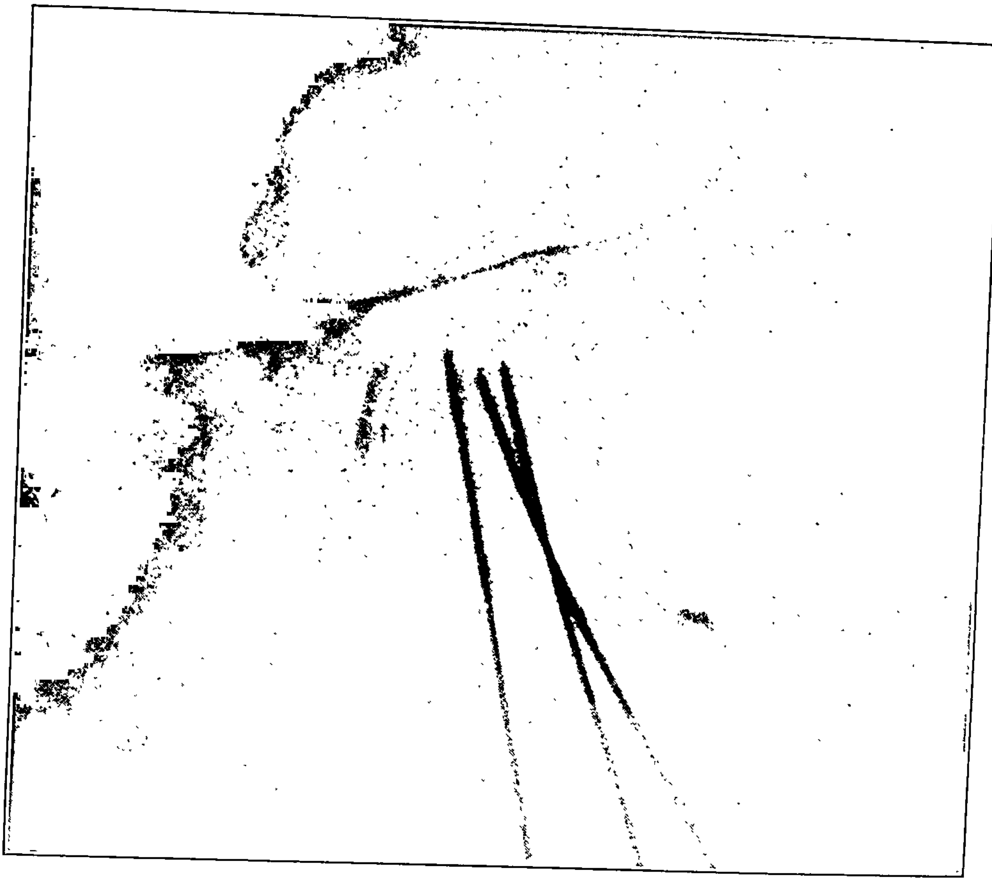

Fig. 9
Case 8. After reduction.

Fig. 8
Case 8. Before reduction.

further or slightly withdrawn until the surgeon is satisfied with their position. The skin is then depressed as far as possible and the wires are clipped with pliers for cutting piano wire over a disc which protects the skin. No dressings are necessary.

In the first cases, we applied a long Thomas hip brace for two or three weeks to prevent displacement of the fragments. This was found to be unnecessary. The only apparatus ever used is a short posterior splint at the ankle, fixed to an eight-inch cross rod to prevent the external rotation which the limb normally assumes in a recumbent position. This is necessary only for very obese patients. The patient, having experienced no shock of anaesthesia, is allowed to sit up in bed immediately and may be placed in a wheel chair within a day or so.

After the reduction and fixation, the fractured neck of the femur may be disregarded as a factor in the treatment of the elderly patient. The

FIG. 10

Case S. End result, January 4, 1934.

Fig. 11

Case 5. Roentgenogram, December 23, 1932, showing fracture of right hip before reduction.

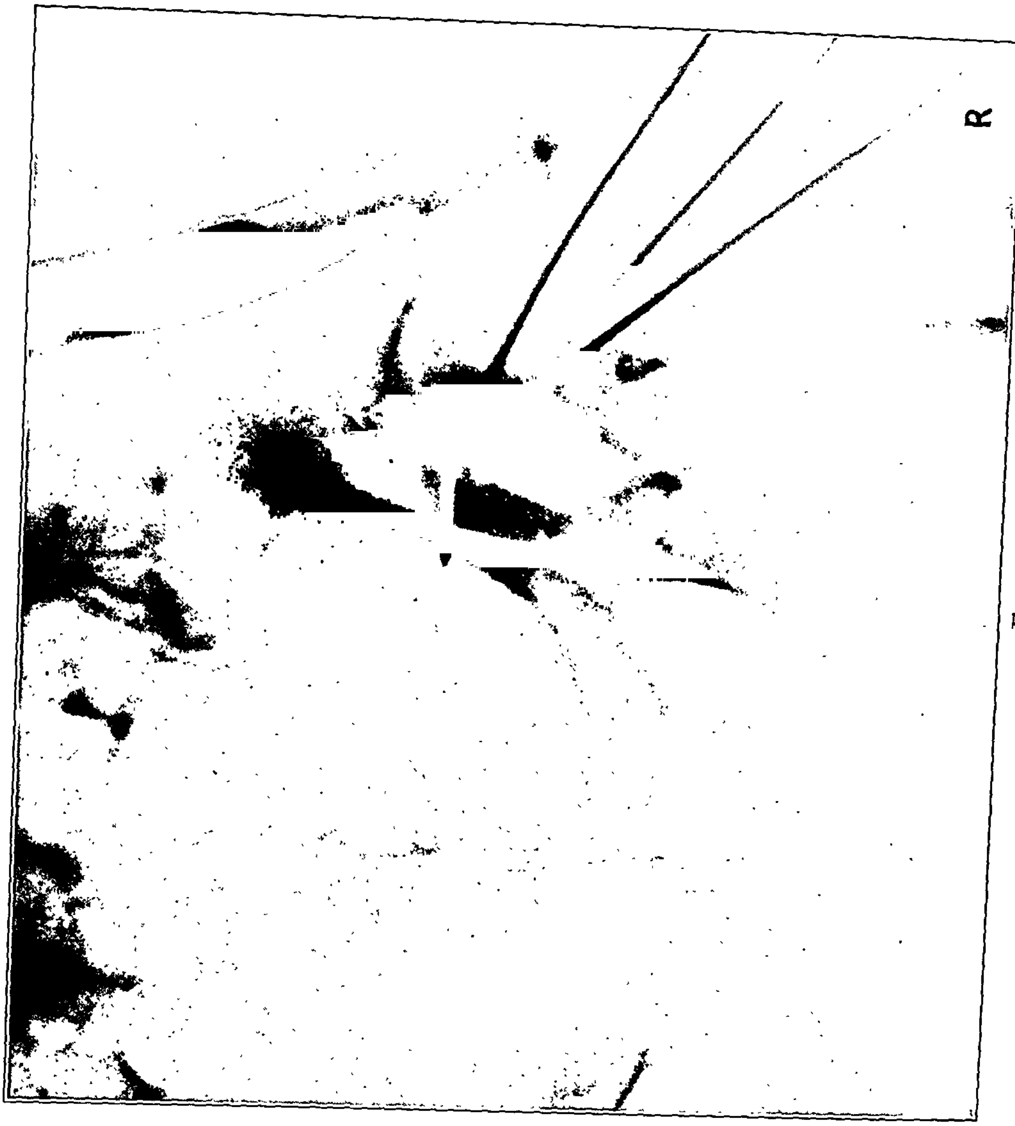

Fig. 12

Case 5. Roentgenogram, January 4, 1933, showing reduction and wires in place. One of the wires has penetrated the head of the femur and the acetabulum. This wire caused no trouble. It was removed with the other wires and the patient has gone on to a complete recovery with union.

FIG. 13

Case 7. Same patient as in Case 5. Roentgenogram, May 16, 1933, showing bony union of the right hip after wires were removed and a fresh fracture of the left hip before reduction.

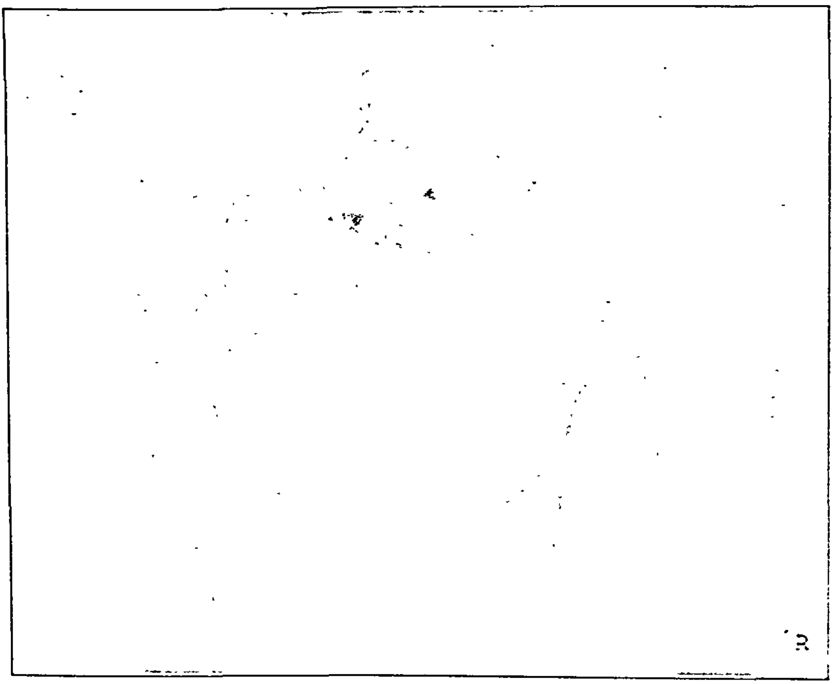

FIG. 14

Case 7. Roentgenogram, March 20, 1934, showing wires removed from both hips and bony union in both hips.

TABLE I

RÉSUMÉ OF CASES OF FRACTURE OF THE NECK OF THE FEMUR TREATED BY WIRE FIXATION

Case No.	Name	Type of Fracture	Age	Date of Fracture	Date of Wiring	Date of Removal of Wires	Result	Remarks
1	G.	Middle of neck	50	Dec. 16, 1932	Dec. 31, 1932	Feb. 13, 1933	Infection; late union.	First case; wires allowed to protrude; manipulated by another.
2	Gr.	Middle of neck	73	Feb. 2, 1933	Feb. 5, 1933	Apr. 20, 1933	Bony union.	
3	R.	Intertrochanteric	65	Dec. 18, 1932	Dec. 21, 1932	Feb. 24, 1933	Bony union.	
4	Gal.	Transcervical	70	Dec. 21, 1932	June 27, 1933	Sept. 25, 1933	Bony union.	
5	C.	Subcapital, right	64	Dec. 23, 1932	Dec. 25, 1932	Feb. 25, 1933	Bony union.	Fractured other hip five months later. See Case 7.
6	K.	Subcapital	63	Feb. 4, 1933	Feb. 7, 1933	May 23, 1933	Fibrous union or non-union.	Patient 5 per cent. diabetic. Soft Kirschner wires were bent.
7	C.	Subcapital, left	64	May 16, 1933	May 16, 1933	Aug. 15, 1933	Bony union.	
8	R. L.	Base of neck	69	May 18, 1933	May 22, 1933	Sept. 8, 1933	Bony union.	
9	L.	Subcapital		June 20, 1933	June 23, 1933	....	Patient died suddenly on June 29, 1933.	Patient irrational at time of wiring; cardiac failure.
10	P.	Epiphysiolysis	12	Nov. 9, 1933	Jan. 14, 1934	Apr. 10, 1934	Bony union.	Open correction plus wires.
11	W.	Transcervical	68	Dec. 12, 1933	Dec. 12, 1933	....	Patient died suddenly, five days after the operation.	
12	E.	Pathological, intertrochanteric	81	Dec. 18, 1933	Dec. 21, 1933	....	Patient died on Jan. 24, 1934.	Carcinoma.
13	H.	Transcervical	78	Feb. 13, 1934	Feb. 15, 1934	Apr. 18, 1934	Fibrous union; drilling added.	Mental case.
14	Sch.	Intertrochanteric	63	Feb. 19, 1934	Feb. 21, 1934	Apr. 20, 1934	Bony union.	Psychotic, requiring restraint.
15	R.	Charcot's joint	45	Mar. 2, 1934	May 17, 1934	....	Patient died on Oct. 9, 1934.	Charcot's joint.
16	I.	Transcervical	46	May 6, 1934	May 29, 1934	Sept. 20, 1934	Bony union.	Weight 275 pounds. Patient 5 per cent. diabetic.
17	Pe.	Intertrochanteric	62	May 22, 1934	May 28, 1934	....	Patient died five months after the wiring operation.	Hemiplegia for seven years.
18	D.	Intertrochanteric	78	June 20, 1934	June 22, 1934	....	Patient died.	Patient 5 per cent. diabetic.
19	Do.	Subcapital	65	June 28, 1934	July 3, 1934	Still in	Delayed union; drilling on Nov. 30, 1934, with impaction.	Pneumonia developed after insertion of the wires, but cleared up after patient was transferred to Medical Service.
20	S.	Intertrochanteric	72	July 7, 1934	July 13, 1934	....	Patient died.	Pulmonary oedema at time of insertion of wires.
21	Z.	Base of neck	52	July 17, 1934	July 23, 1934	Oct. 30, 1934	Bony union.	Ambulatory with aid of crutches while wires remained in place.
22	B. K.	Transcervical	56	July 17, 1934	July 28, 1934	Sept. 30, 1934	Bony union.	
23	A.	Subcapital	52	Aug. 12, 1934	Oct. 12, 1934	Still in	Patient still under treatment.	Open correction plus autogenous bone pegs.
24	Ra.	Subcapital	75	Oct. 1, 1934	Oct. 4, 1934	....	Patient died.	Hypertension; sugar present in p.m. specimen of urine.
25	T.	Transcervical	45	Oct. 24, 1934	Nov. 7, 1934	Still in	Patient still under treatment.	

long period of recumbency necessitated by plaster-of-Paris methods of fixation constitutes the major mortality hazard in the treatment of a fractured neck of the femur. The type of internal fixation described in this paper allows the patient to be turned as often as necessary and to sit upright. At the end of ten weeks, if the x-ray shadow shows that sufficient union has taken place, the wires are removed under local anaesthesia through a two-inch lateral incision. It has been found necessary to use as much as forty to fifty pounds of pull, measured by the spring balance, to withdraw the smooth wires. The threaded wires are fixed more firmly than this. The strength of the wires has been found sufficient in all cases to maintain apposition.

The method has also been found useful in allied conditions. In epiphysiolysis, where the fracture has been reduced by either the open or closed method, the wires may be used to maintain apposition. This is of particular value inasmuch as the type of patient to whom this accident usually occurs is the obese individual with Frölich's syndrome, in whom plaster fixation is insecure and uncomfortable. The effort to reestablish motion within the hip joint may be begun within a few days after reposition and wiring. In subtrochanteric osteotomy and in arthrodesis of the hip joint, wiring may replace the spica.

A summary of the clinical results in twenty-five cases is given in Table I. At first glance, these figures seem to indicate an unusually high mortality. This is due to the fact that, far from selecting cases, we have performed the wiring operation in a number of cases when from the outset an unsuccessful issue was almost inevitable. We were led to do this for two reasons: first, because of the pleas of relatives and family physicians to whom the simplicity of the method appealed as the one hope in an otherwise hopeless situation; second, because we felt, in testing out a new method, experience was of more value than an impressive series of statistics. This attitude of ours will explain why we were willing to use this procedure in Cases 9, 12, 17, 18, 20, and 24,—patients in whom the prognosis was bad from the outset. These cases include one of carcinoma, one of pulmonary oedema, one of pneumonia at the time of wiring, one of Charcot's joint, and two of diabetes (each with 5 per cent. sugar). If these cases are excluded, which seems to us logical, we are left with nineteen cases in two of which the patients are still under treatment. In these nineteen cases, there were two deaths, both of which we believe were unavoidable; one death was due to an embolus and the other, to pneumonia in a patient with marked hypertension and abdominal distention. Of the seventeen cases which have been followed for a period of from one to three years, bony union has occurred in twelve and fibrous union with good function in three. Of the nineteen cases which can logically be included in an analytical group of statistics to determine the value of the method, death has ensued in two, bony union in twelve, fibrous union in three, and in two cases the patients are still under treatment with wires in place and fragments in good position.

CONCLUSIONS

The subcutaneous-wire-fixation method has the following advantages:

1. General anaesthesia is dispensed with. This is of paramount importance in the age group in which this type of fracture is frequently found.
2. The threat of hypostatic pneumonia and decubitus is not present, as it is where plaster fixation is used.
3. Absolute fixation of the fragments is maintained. This is true where, despite the drilling of the fragments, aseptic necrosis of the neck takes place. In these cases, as is seen in the roentgenograms, the distal fragment slides along the wire maintaining its apposition to the capital fragment. This is not true in plaster fixation, where, as crumbling of the neck takes place, the shaft fragment rides upward.
4. The method is simple, atraumatic, requires no incision, and is easily carried out even in the patient's home if the x-ray facilities can be supplied.

SUBCUTANEOUS SPIKE FIXATION OF FRESH FRACTURES OF THE NECK OF THE FEMUR *

BY F. J. GAENSLEN, M.D., MILWAUKEE, WISCONSIN

The method to be described for the reduction and subcutaneous spike fixation of fractures of the neck of the femur has been used by the author in ten cases and appears to merit consideration for the following reasons:

1. Reduction is based on what are considered sound anatomical principles.
2. Roentgenographic control of reduction, as well as of spike fixation, in true anteroposterior and lateral views is adequate.
3. Open incision is avoided.
4. The internal fixation without the addition of external support is sufficiently firm to permit immediate active motion,—the best form of physical therapy.

TECHNIQUE

Scopolamine-morphine anaesthesia has been found very satisfactory since it provides for analgesia as well as entirely adequate muscular relaxation for several hours. While reduction is accomplished in a few minutes, frequent x-ray control during the spike fixation may prolong the time that the patient is on the operating table to two hours.

The first step is to take x-rays of both hips in the anteroposterior view, with the sound hip rotated inward about 15 degrees to prevent a foreshortened appearance of the neck, due to anterior inclination (Fig. 1). This anteroposterior view discloses, first, the site and character of the fracture on the injured side and, second, the normal angle of neck and shaft as well as the length of the neck on the well side. A short centimeter rule, four to six centimeters in length, fixed directly over the trochanteric region with adhesive plaster, is of value in eliminating distortion in determining the actual length of the neck on the well side. A lateral view of the sound hip is then taken to determine the angle of anterior inclination.

REDUCTION

Previously prepared posterior plaster half shells, well padded and of a size to fit the average patient, are applied to both lower extremities with the hips and knees flexed to right angles to provide muscular relaxation. While an assistant holds down the pelvis securely, strong upward traction is made in the direction of the long axis of the femur (Fig. 2). In the reduction of experimental fractures in the anatomical laboratory,

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flexion of the hip to 90 degrees proved effectual in removal of the capsule when interposed. In reality, the fragments are withdrawn from the capsule which remains firmly attached at the upper acetabular margin. Lateral pressure on the trochanter is then made to correct possible anteroposterior displacement. Laboratory studies show that such displacement is most apt to be a forward displacement of the trochanteric fragment on the neck fragment.

It appeared evident that reduction was completed by these manoeuvers,—that is, flexion of the hip to 90 degrees, traction upward, and pressure against the trochanter for the correction of anteroposterior displacement. In other words, further manipulation in order to bring the extremity into full extension, as in the Whitman method, is not a necessary further step in reduction.

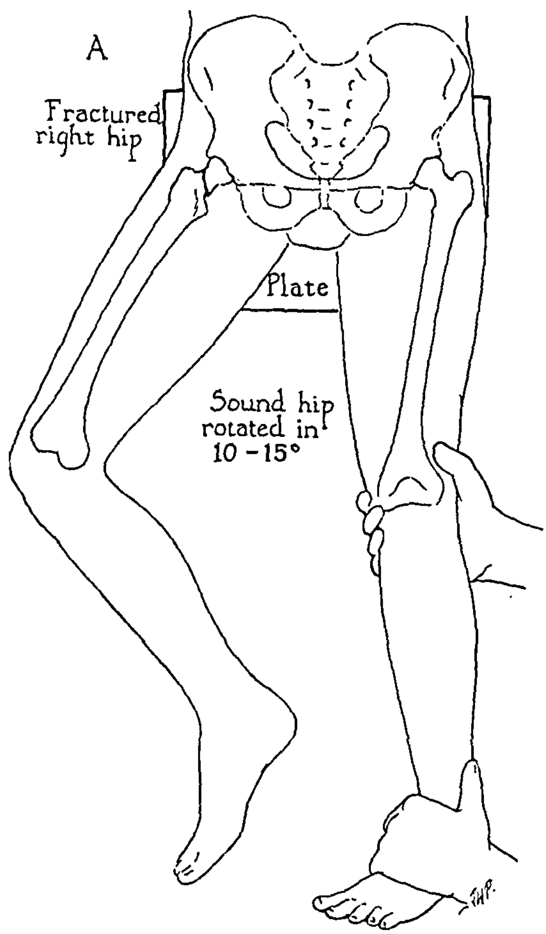

FIG. 1

An anteroposterior roentgenogram is taken with the fractured hip in the position of deformity and the sound hip rotated inward about 15 degrees.

However, abduction, maintained by the adjustable cross bar, is added to fix firmly or to lock the fragments and also to make possible the taking of x-rays in both anteroposterior and lateral views without shifting the patient's position. It has seemed desirable, therefore, to attempt to fix the fragments in this position without jeopardizing the reduction by endeavoring to bring the extremity down to the horizontal.

Since steel knitting needles have been used in many instances in the fixation of certain fractures, as well as in arthrodesis of joints after resection, this method has also been employed by the author for fixation of fractures of the neck. In the anatomical specimens three knitting needles proved sufficient to provide firm fixation, especially when the needles were introduced not parallel but at slight angles to one another.

Internal screw or nail fixation in fractures of the neck is not new. Von Langenbeck in the 1850's was perhaps the first to use the method. He was followed by König in 1875, by Trendelenburg in 1878, and by Lister in 1880. Lemon, of Milwaukee, did his first subcutaneous spiking

in 1913, using a large ordinary wire nail without external fixation. He operated on forty-four patients and believed himself to be the first to use this method, but found out later that Nicolaysen, of Christiania, now Oslo, had preceded him by eighteen years, although Nicolaysen added plaster fixation to his spiking. Smith-Petersen's special flanged nail appears to be an excellent means of fixation. Sven Johansson used the Smith-Petersen nail, placed in position by a Kirschner wire as guide. Wescott uses the Smith-Petersen nail through a small incision over the trochanter, practically subcutaneously. Metal-pin fixation has been used more recently by Moore, Knowles, Ransohoff and Telson, and by the writer, each developing his own technique independently. Utilization of flexion rather than extension was strongly advocated by Dupuytren before 1835. It was later recommended by Maxwell in 1870, by Ruth in 1901, and by Leadbetter in 1932.

It was realized that in the living, the introduction of spikes without open incision, at least down to the trochanter, would be difficult, but a method has been worked out which is satisfactory, though by no means simple, since in a large fleshy hip even the trochanter is not always readily palpable and since the target aimed at—the cross section of the cancellous portion of the neck—is comparatively small. Therefore, in order to facilitate introduction of the spikes, the hip is abducted to bring the neck parallel to the surface of the table and rotated inward sufficiently to allow for the anterior inclination of the neck, thus bringing the neck not only parallel to the table, but perpendicular to the long axis of the patient. The advantage of this position is evident, since it is obviously less difficult to direct a drill on the level and perpendicular to the table edge than in a line calculated to allow for the normal angle of the neck and shaft as well as for the anterior inclination (two angles in different planes).

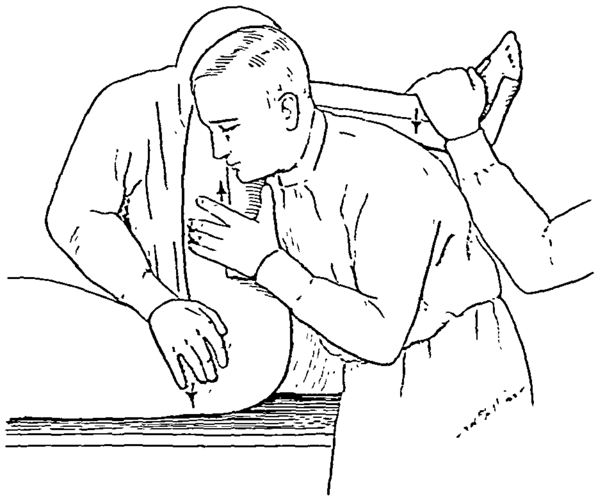

FIG. 2

When the affected leg has been protected by a padded plaster shell and the pelvis fixed by an assistant's hands, strong vertical traction is made.

A further advantage lies in the fact that in the abducted position the fragments are held in firm coaptation, thus preventing the tendency to separation of fragments as the spikes engage in the head.

In the author's earlier cases, the extremities, still supported in the

plaster half shells, were at this point suspended from an overhead frame, the horizontal bars of which were high enough to allow clearance for the x-ray tube. More recently the extremities have been supported on pedestals adjusted so that the pelvis is raised or jacked up one inch above the surface of the table, thus providing continuous body-weight traction, assuring maintenance of the proper relation of the fragments, and, at the

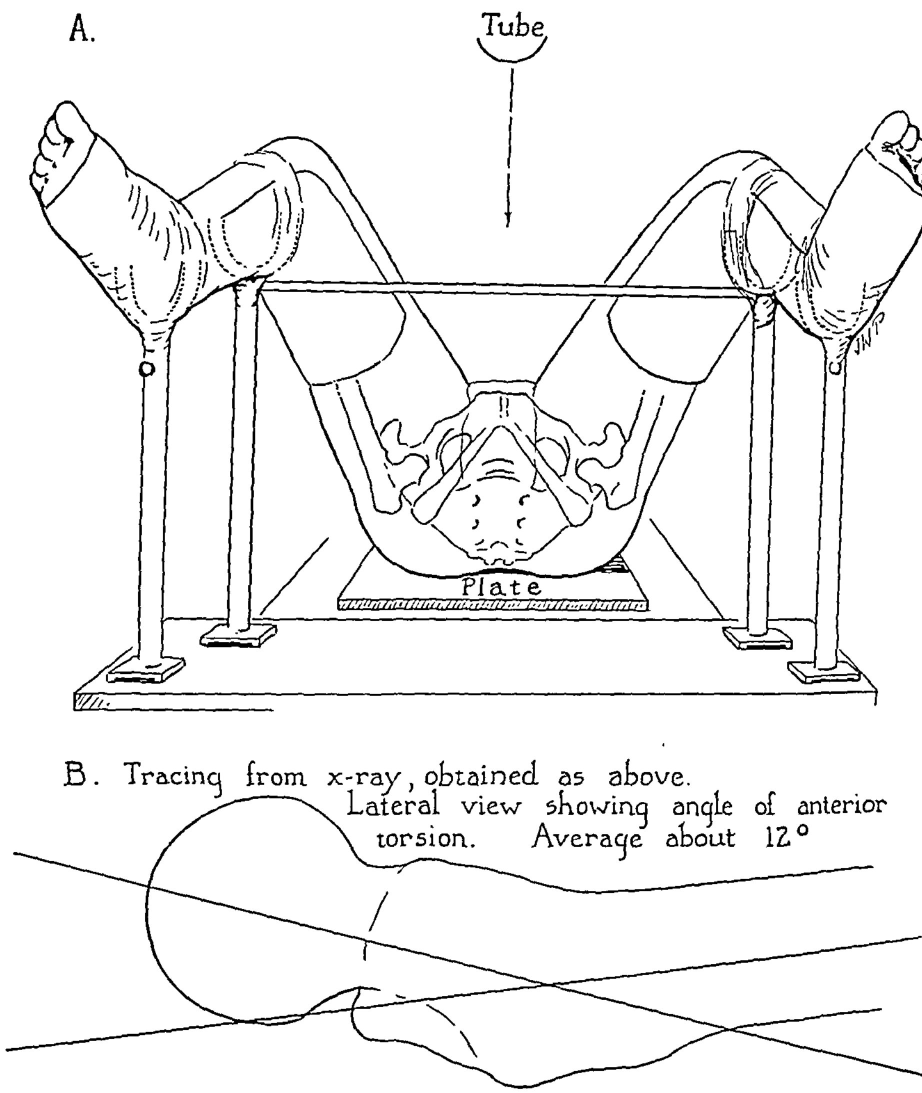

FIG. 3

Fig. 3–A: Without moving the patient, it is possible to slip a plate under the buttocks and to obtain a lateral view of the affected hip.
Fig. 3–B: Tracing of lateral view showing angle of inclination.

same time, allowing an x-ray cassette to be placed under the hip without disturbing the patient's position (Fig. 3).

The skin is then surgically prepared and a sterile, coarse netting is stretched over the affected hip and held taut by rubber bands to displace the heavy adipose layer which otherwise proves annoying. The trochanter limits are now indicated on the skin surface by thrusting three

hat pins into the hip region, parallel to the long axis of the neck, in such a manner that they pass tangentially over the anterior and posterior margins as well as the tip of the trochanter (Fig. 4). With these pins to serve as landmarks, the cross section of the neck—the target to be aimed at—can be more readily visualized. This target is roughly one and eight-tenths centimeters by two and five-tenths centimeters in diameter. Its center will lie about four centimeters above the pin marking the tip of the trochanter and about two centimeters distal or caudad to the pin marking the anterior limits of the trochanter. Into this area two Kirschner wires (Fig. 5) are now introduced, about one centimeter apart and to a depth of about twelve centimeters, in the attempt to traverse the neck and head and to engage the acetabulum, in order to prevent the almost certain tilting of the head when the heavier fixation pins are driven. These wires are now identified with lead markers and anteroposterior and lateral x-rays are taken, as shown in Figures 6 and 3, respectively, to determine whether reduction and insertion of Kirschner guide wires are satisfactory. If not satisfactory, efforts at more perfect reduction and insertion of guide wires are necessary. If the fracture surfaces overlap even slightly, the target is naturally reduced in size and the difficulties of spiking are materially increased.

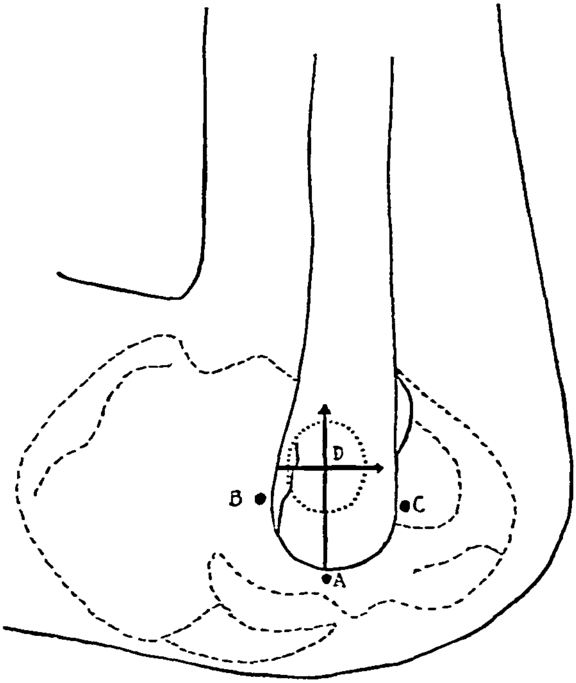

FIG. 4

Showing lateral view of fractured right hip. The hat-pin guides, *A*, *B*, and *C*, just graze the anterior and posterior margins of the trochanter as well as the tip and serve as landmarks. The central axis of the neck of the femur lies about four centimeters above point *A* and two centimeters caudad to point *B*. *D* represents the central axis of the neck.

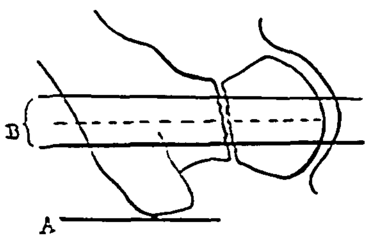

FIG. 5

A: Hat-pin guide just grazing the trochanter. *B:* Kirschner wires transfixing fragments and engaging in acetabulum to prevent tilting of the head when the fixation spikes are driven in.

INTRODUCTION OF FIXATION SPIKES

Through a tenotomy-puncture wound the first fixation spike is now introduced. These spikes are made of rustless steel, three thirty-seconds of an inch in thickness. The spike, steadied by a large guide clamp in the hands of an assistant to prevent "creeping" of the drill point on the hard, curved, bony surface and to insure engagement in the cortex at the exact point selected, is now drilled into the bone to a depth of from three to four centimeters. The coarse netting stretched tautly over the trochanteric region is of help in preventing the tissues from "winding-up".

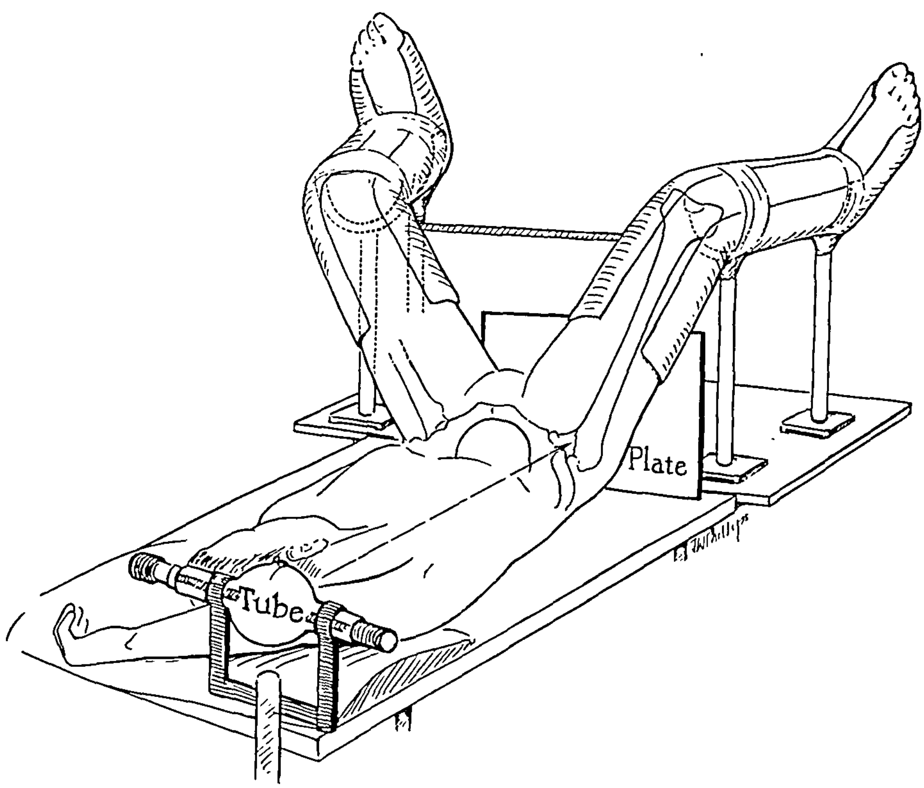

FIG. 6

An anteroposterior roentgenogram is obtained with the plate against the thigh in a plane perpendicular to the long axis of the body and with the tube near the shoulder on the same side.

The spike is then driven deeper with a mallet until its tip just engages the cortex of the head. This point is detected not only by the sense of suddenly increased resistance, but also by the sound. The latter is readily appreciable to those standing near. If the placement of this spike is satisfactory, as disclosed by anteroposterior and lateral x-rays, two to four additional spikes are inserted; the sites for introduction and the angles with reference to the first or guide spike are determined by a study of the roentgenograms. While the introduction of four additional spikes may seem like a good deal of hardware it is well to have this number. If all five spikes are ideally placed, one can readily be removed. A few additional drill holes through the neck certainly do no harm. On the con-

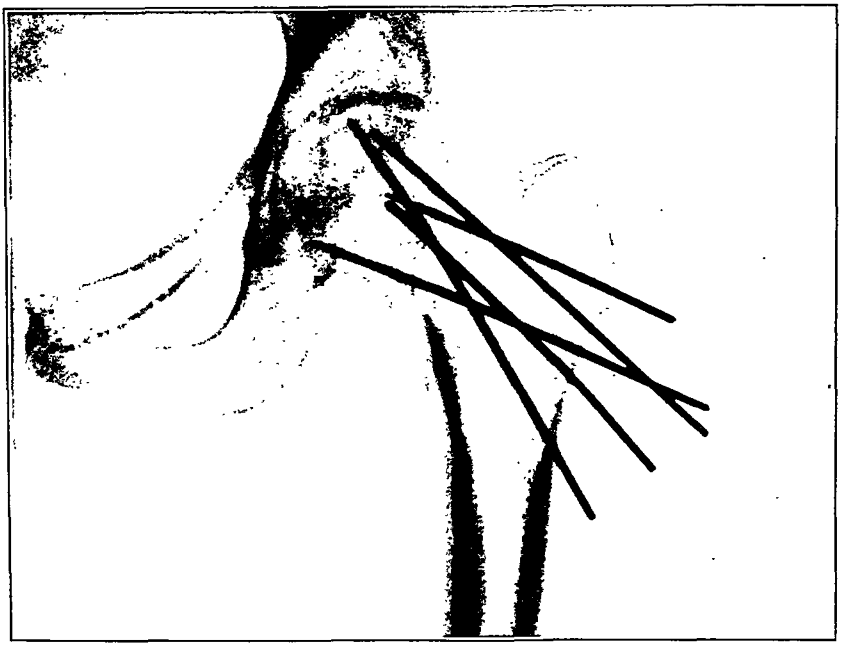

Fig. 7

Patient, aged seventy-five. Anteroposterior view. The spikes are cut off as short as possible. The Kirschner wires and the hat-pin guides have been withdrawn.

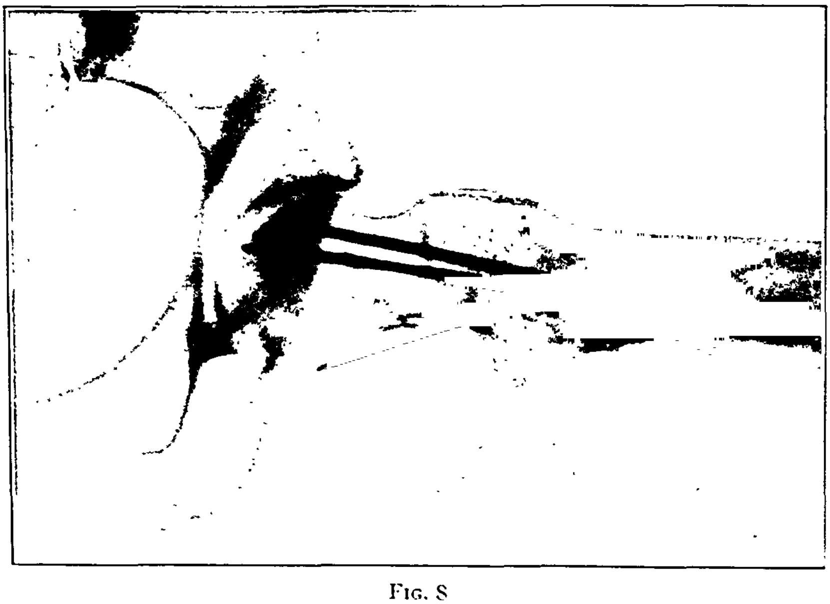

Fig. 8

Lateral view, same case, showing fixation with five spikes, two of them superimposed. Reduction very satisfactory.

trary, drilling of fracture surfaces to improve circulation is considered good surgery. Only recently Bozsan employed this procedure as an accessory to the Whitman abduction method. If, as is not unlikely, one or two spikes have missed the mark, they may be withdrawn and still leave three, which is considered a sufficient number for firm fixation. The hat pins marking the trochanter limits, as well as the two Kirschner wires engaging the acetabulum, are now removed. The heavier fixation spikes are identified with lead markers and further x-rays taken. These will disclose whether or not the fragments are properly transfixed, also whether or not the spikes are driven to the desired depth. These spikes are driven deeper or partially withdrawn as the case may be. Final x-rays are now taken. If the position is satisfactory, the spikes are cut as short as possible (Figs. 7 and 8). The skin is drawn over the ends and a dressing applied over the puncture wounds. The patient is placed in bed with the leg resting on a pillow under the knee. Sling suspension may be added for comfort and to initiate active motion even on the first day. Full tub baths with underwater exercises were given several of the writer's patients as early as the second day. The spikes are removed in about three months.

ADVANTAGES

1. The operative risk is so slight that the procedure is applicable to the old and feeble.

2. Fixation is sufficiently firm to render external fixation unnecessary.

3. Postoperative pain is negligible; the patients are at once relieved of discomfort. In some instances, after the patients had taken active exercise for some weeks, the spikes became readily palpable under the skin, causing irritation, and were cut shorter.

4. Physiotherapeutic measures, including active motion, are possible almost immediately. In several instances the patients were put in the Hubbard tub forty-eight hours after the operation. The puncture wounds were protected by a collodion dressing. Due to the buoyancy of the water, a fairly free range of painless motion is possible at once.

5. Nursing care is facilitated because of the relative freedom of movement. Decubitus, as well as stiffness of the knee, is avoided because of lack of external fixation.

DISADVANTAGES

1. The technique is exacting and somewhat difficult, especially because of the need of working on the lateral aspect of the abducted and flexed hip, the price paid for the advantage of introducing the guide spike in the horizontal plane and at right angles to the table edge.

2. There is danger of wounding important soft parts. While individual spikes have been driven too deeply in some instances, even missing the head entirely in others, no serious consequences have occurred in the writer's series.

3. Wandering of the spike into the pelvis, necessitating laparotomy r removal, has been reported. It is believed that the employment of ikes with sharp-edged but only slightly pointed drill ends and the 'oidance if possible of penetration of the cortex of the head may over-me the danger of wandering.

4. There is danger of infection about the spikes. In several in-ances irritation and redness and a collection of seropurulent exudate, egative on culture, have occurred about the ends of the spikes, but there as been no actual infection up to the present time *. It is felt that ere is slightly greater danger of infection by this method, because of the eedom of movement allowed, than by other methods in which metal ns are used.

5. The spikes may break. In one of the early cases in which rdinary steel knitting needles were used, all three needles broke at the acture line. This has not occurred since using the heavier rustless steel pikes.

6. Peroneal palsy on the uninjured side resulted in one case from nsufficient padding about the fibular head and consequent pressure of ne plaster shell on the peroneal nerve.

CONCLUSIONS

A method is described of reducing and fixing fractures of the neck of ne femur under scopolamine-morphine anaesthesia with adequate roent-enographic control both in anteroposterior and lateral directions, without kin incision, and without external fixation.

It is not claimed that the procedure will solve the problem of treating ractures of the neck of the femur, but it is believed that it merits con-ideration. The method has been used in ten cases. The results have een sufficiently encouraging to warrant continued use. A report on end esults must be deferred to a later date.

* Since this paper was presented, two infections have been encountered. One case, econdary to skin necrosis about the nail ends, occurred about six weeks after spike ixation. Death from bronchial pneumonia resulted some weeks later. While sero-urulent fluid was found in the hip joint, there were no clinical signs of infection of the ip joint. In another case, superficial infection occurred on removal of the spikes about en weeks after insertion.

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DESTRUCTIVE SPINE LESIONS

Diagnosis by Needle Biopsy*

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Diagnosis in the more common destructive spine lesions is usually made with a fair degree of accuracy in the advanced stages. Early diagnoses are generally presumptive and attended by much difference of opinion. Frequently it is impossible to state with certainty whether an area of rarefaction, found by x-ray, is infectious or neoplastic in origin. When tissue can be obtained for microscopic study, correct diagnosis is usually possible.

The needle is probably one of the first instruments employed in the diagnosis of subcutaneous pathology. Ward[1] first suggested its use for the aspiration of tissues in 1912. It has been utilized in the diagnosis of bone lesions by Martin and Ellis[2]; Coley, Sharp, and Ellis[3]; and Hoffman[4]. Its use for biopsy in spine lesions was first reported by one of us[5] in 1934.

The anterior portion of the spine is not readily reached by the usual biopsy procedures, yet it is for the most part quite accessible to needle exploration. We have utilized such a procedure since 1932 in the diagnosis of fifteen cases presenting indeterminate pathology in the spine. In six cases, microscopic study of the tissue obtained permitted positive diagnosis of malignancy. In all, the biopsy diagnosis was confirmed clinically and in two cases was proved by post-mortem examination. To date, no case in which a microscopic diagnosis of non-malignancy was made has subsequently shown malignant changes. The procedure has proved of the greatest value in differentiating between malignant and other lesions, and of the least value in determining the specific organism in infectious lesions. The technique is relatively simple in fluid media or a friable tumor, and is difficult in cartilage and fibrotic areas.

It is fully realized that needle biopsy is a somewhat blind procedure under the most favorable conditions. This is particularly true of its use in the spine, yet we feel that to date no more accurate or satisfactory method has been devised. It can be used with a fair degree of accuracy and a high degree of safety in lesions of the spinous process, lamina, vertebral body, intervertebral disc, or surrounding soft tissues.

* Presented at the Annual Meeting of the American Academy of Orthopaedic Surgeons, New York, N. Y., January 16, 1935.

TECHNIQUE

The technique employed by us is as follows: The skin is prepared, draped, and, with the underlying soft tissues, is infiltrated with 1 per cent. novocain. The point of a No. 18 or No. 16 needle, four inches in length, is introduced into the tumor area, the trocar removed, and a fifty-cubic-centimeter glass Luer syringe attached. The plunger of the syringe is withdrawn as far as possible and the vacuum maintained while the point of the needle is moved backward and forward for a distance of from five to twenty-five millimeters within the tumor area. Marginal tissue is obtained if possible. When sufficient tissue has been aspirated, the needle is withdrawn. It is essential that a constant vacuum be maintained throughout the entire procedure, in order that the needle may be cleared of all tissue on withdrawal. A small amount of sterile saline is then drawn into the syringe through the needle, the plunger withdrawn, and the contents of the syringe is emptied onto a piece of gauze or blotter. Cultures are made, all bits of tissue are separated from blood clot, piled together on a small piece of dry paper, and dropped into fixing fluid. Care must be taken to obtain all of the tissue fragments washed from or adhering to the barrel or plunger. All of the clotted blood must be teased apart to be certain that no tissue fragments are overlooked. Unless these details are carefully observed, many successful aspirations will be classed as failures.

DISCUSSION

To date, no difficulty has been encountered in obtaining sufficient tissue for examination on the first attempt. Repetition has been necessary in two cases in which doubtful malignant changes were found in the first tissue removed. Tissue has been obtained from the disc with difficulty when low-grade infectious changes were present, but in no case of neoplasm has difficulty been encountered in obtaining large amounts of tissue from any portion of the spine involved.

Microscopic diagnosis has been attempted only from paraffin sections. We feel that this slight delay is more than offset by the greater certainty of such a procedure. We have found that anyone trained in microscopic pathology experiences no difficulty in interpreting such preparations. A careful search must be made of all parts of the slide, as the bits of tissue are removed from varying areas within and around the tumor, and only one fragment may show pathology.

The method described may be employed without general anaesthesia, hospitalization, or special instruments. It is usually readily accepted by the patient and does not produce great discomfort. A minor break in the tumor capsule is produced, and the surgical risk is trivial. With this technique, it is possible to make an accurate tissue diagnosis in many early cases. It may be repeated if desired.

The use of this procedure is limited by its relative blindness in exploring deeply buried lesions, the difficulty of obtaining cartilaginous or fibrous material, the frequent impossibility of selecting marginal tumor

FIG. 1

Case 1. R.D.L. Lateral roentgenogram, one year after onset of symptoms, showing collapse of body of twelfth dorsal vertebra, with preservation of intervertebral spaces.

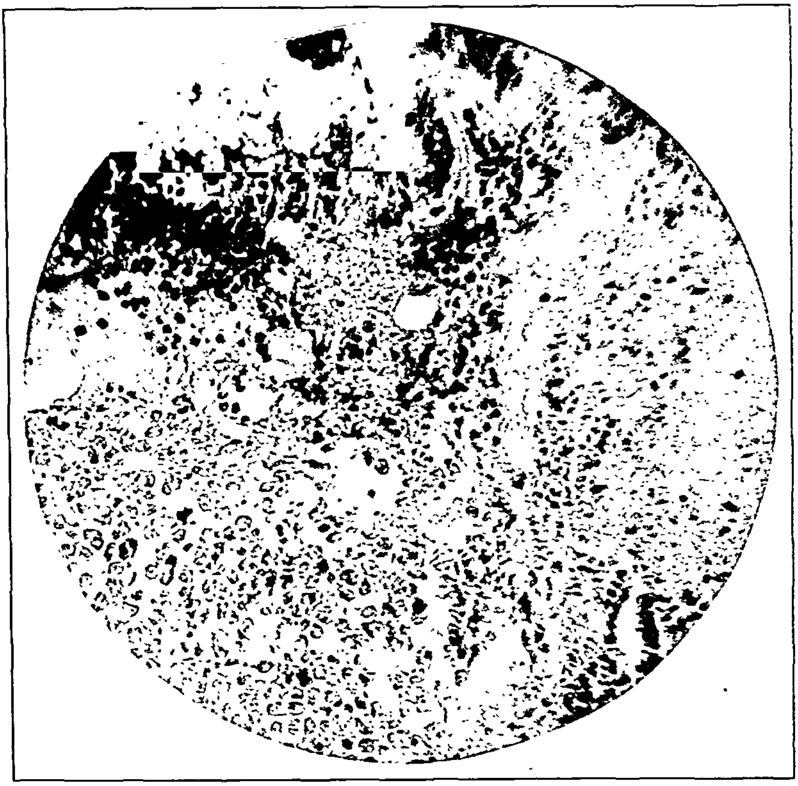

FIG. 2

Case 1. R.D.L. Section of tissue removed by needle biopsy. Plasma-cell myeloma.

tissue, and the danger of injury to cord roots or other adjacent soft tissues.

The following cases are presented to demonstrate the value of this procedure.

CASE REPORTS

CASE 1. R. D. L., white, male, forty-eight years of age, a merchant, was admitted to the Hospital in January 1933, because of pain in the lower lumbar area, which was referred into both lower extremities, and "indigestion". Symptoms were of one year's duration and increasing in severity. He had been bedfast for the preceding six months.

Three years previously he had fallen from a height of three feet with subsequent dorsolumbar pain which was treated by recumbency for several weeks with complete symptomatic recovery.

Roentgenograms showed complete collapse of the body of the twelfth dorsal vertebra. X-rays of the other bones, chest, and gastro-intestinal tract disclosed no pathology. The urine showed no Bence-Jones protein.

Tissue removed by needle aspiration showed plasma-cell myeloma.

At necropsy, four months later, the tumor was found to be limited to an area ten

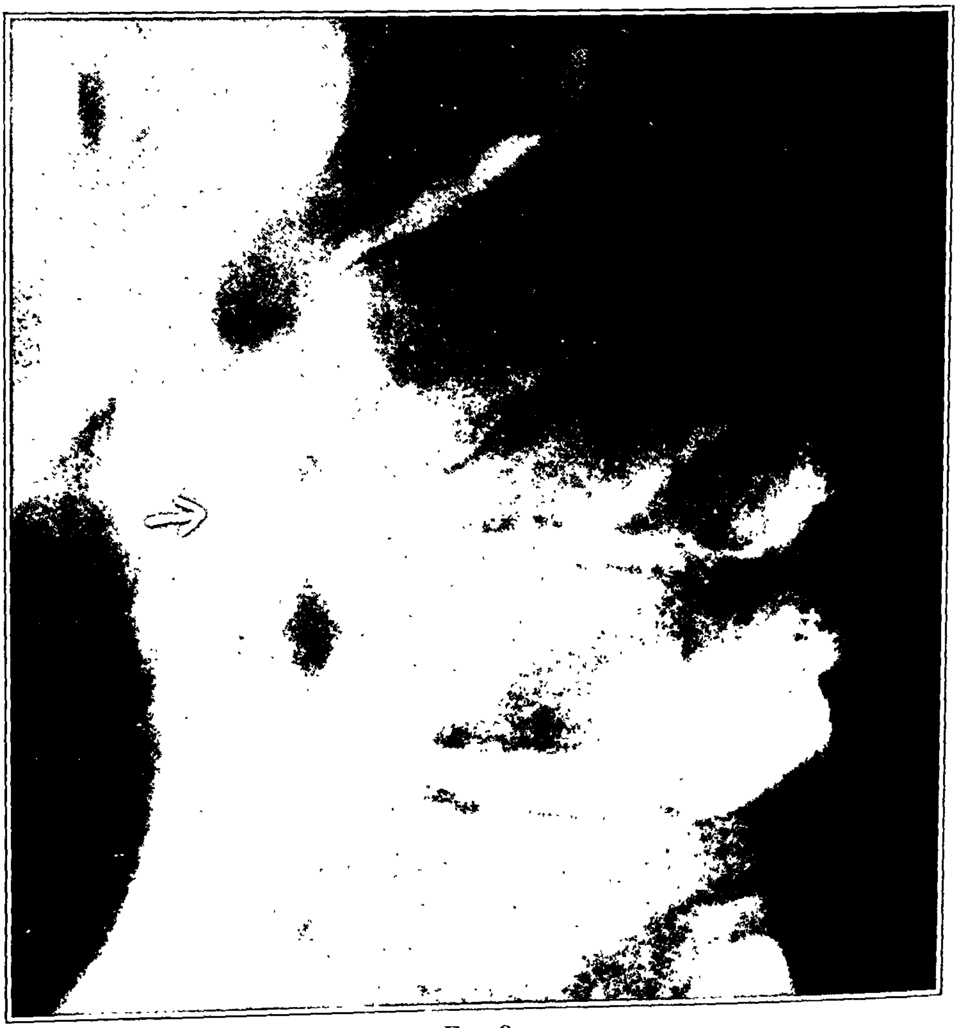

FIG. 3

Case 2. A.L.F. Lateral roentgenogram, three days after onset of symptoms, showing wedging and decreased density of body of sixth dorsal vertebra, with narrowing of intervertebral spaces.

centimeters in diameter. No metastases were found.

CASE 2.* A. L. F., a white girl, eighteen years of age, was admitted to the Hospital in August 1933, complaining of mid-dorsal pain and paralysis of the lower extremities, which she attributed to a direct injury received while jumping into a truck six days before. The symptoms were of three days' duration.

The father had active pulmonary tuberculosis. The patient had had many boils three months before injury.

At examination there was local pain on pressure over the sixth dorsal vertebra with complete motor and sensory paralysis distal thereto. The temperature was 101 degrees, the pulse 108, and the white count 13,400, of which 92 per cent. were polynuclears.

Roentgenograms showed marked wedging and loss of density of the body of the sixth dorsal vertebra.

By needle aspiration, thirty cubic centimeters of thick yellowish-white pus was obtained, which on culture gave a growth of staphylococcus aureus.

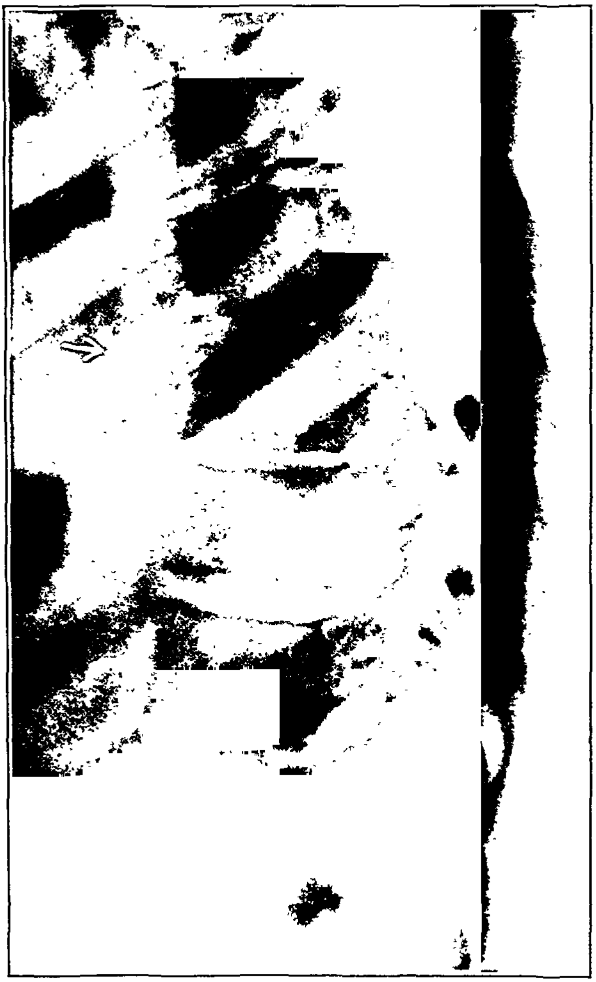

FIG. 4

Case 3. B.F. Lateral roentgenogram, sixteen days after onset of symptoms, showing destructive changes in anterior portion of eighth dorsal vertebra, with narrowing of intervertebral spaces.

Four months later, the motor and sensory changes had disappeared except for bilateral drop-foot. The patient died of lobar pneumonia eight months after the original injury.

CASE 3. B. F., a Negress, single, twenty-one years of age, was admitted to the Hospital in April 1933, because of pain in the right lumbar region, which she attributed to an injury received in jumping from a five-foot wall two days previously.

On admission, the temperature was 102 degrees and the blood count showed 12,800 leukocytes, of which 65 per cent. were polynuclears. A catheterized specimen of urine showed three to four pus cells to the field. A complete genito-urinary examination was negative.

Roentgenograms of the spine, made two weeks after admission, showed destructive

* Patient of Dr. W. R. Buttram.

changes of the anterior portion of the body of the eighth dorsal vertebra, narrowing of the seventh, eighth, and ninth interspaces, a mass to the right of the mid-line extending from the seventh to the tenth dorsal vertebrae inclusive, and apparent destructive changes involving the neck of the right eighth rib. Roentgenograms of the chest showed no definite pathology.

On needle aspiration, fifty cubic centimeters of pus was obtained which, on guinea-pig inoculation, was positive for tuberculosis.

On May 9, the fifth to the eleventh dorsal vertebrae inclusive were fused under local anaesthesia. Recumbency was maintained until September 12, when roentgenograms revealed increased destruction of the body of the eighth dorsal vertebra and extensive destruction and collapse of the eleventh dorsal vertebra.

The patient died nine months later of pulmonary tuberculosis.

Case 4. J. M., Negro, twenty-four years of age, a laborer, was admitted to the Hospital in January 1934, complaining of low back pain and pain in the right hip of five weeks' duration, which for the preceding three weeks had necessitated recumbency.

The patient gave a history of gonorrhoeal urethritis in 1930, and typhoid fever in September 1933.

On admission, the temperature was 101 degrees and the blood count showed 6,700

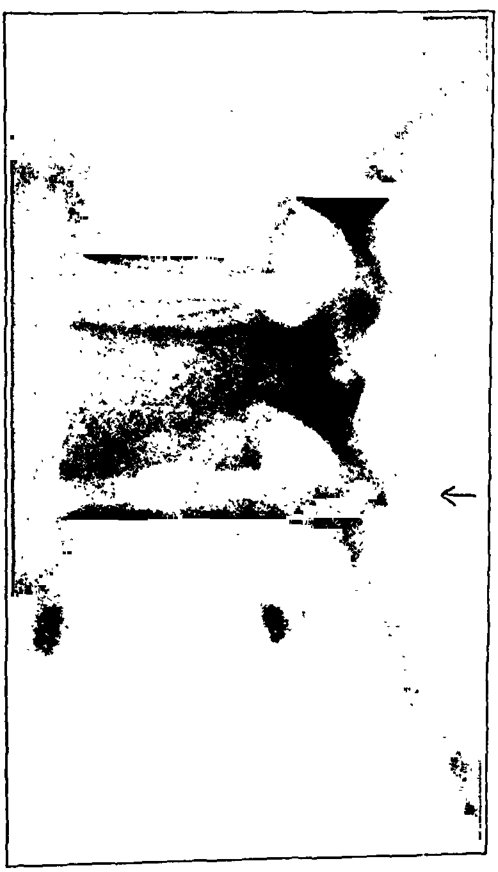

Fig. 5

Case 4. J.M. Lateral roentgenogram, five weeks after onset of symptoms, showing destructive changes involving the third and fourth lumbar vertebrae adjacent to the interspace which is narrowed.

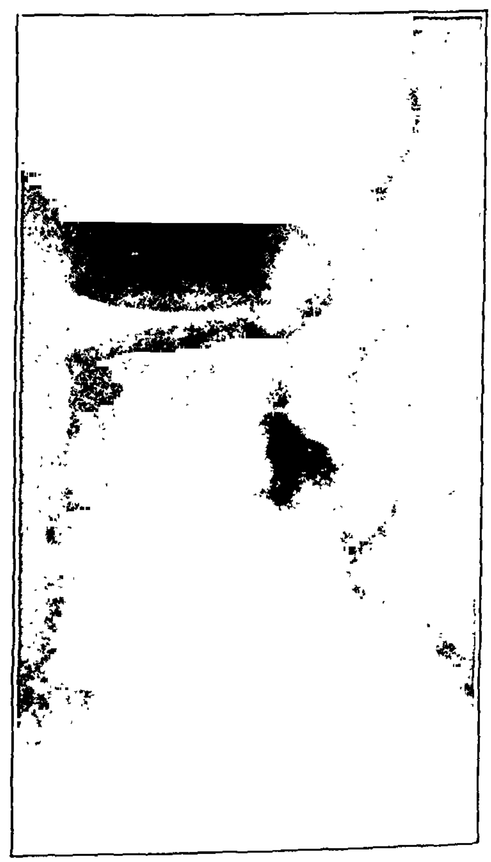

Fig. 6

Case 4. J.M. Lateral roentgenogram, six months later, showing destructive changes involving adjacent surfaces of third and fourth lumbar vertebrae, with bony bridging of anterior portion of involved vertebrae and marked narrowing of interspace.

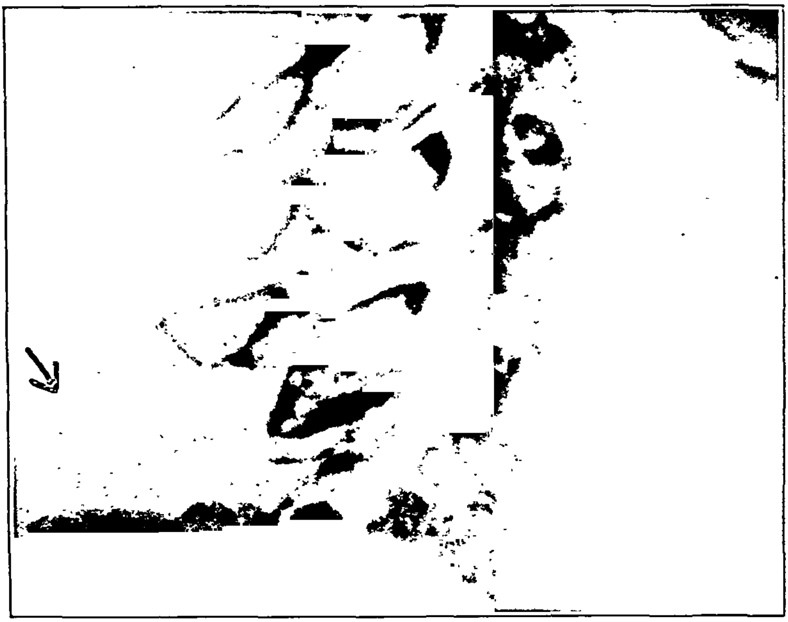

FIG. 7

Case 5. G.G. Lateral roentgenogram, two months after onset of symptoms, showing destructive changes involving spinous process of sixth cervical vertebra.

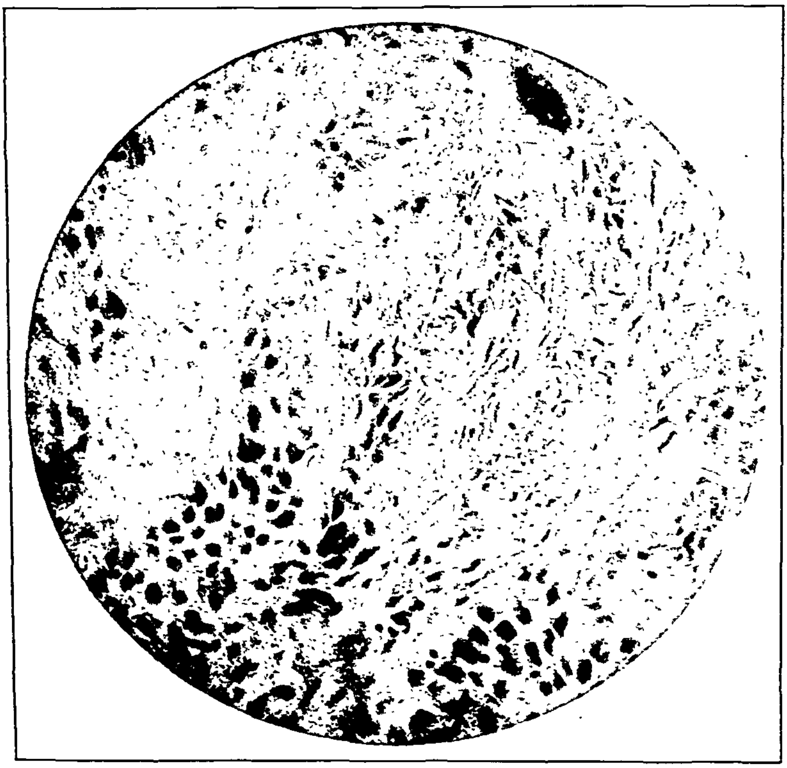

FIG. 8

Case 5. G.G. Section of tissue removed by needle biopsy. Squamous-cell carcinoma.

leukocytes, of which 47 per cent. were polynuclears. The Widal test showed a titer of positive serum at 1:640 dilution.

Roentgenograms revealed destructive changes involving the third and fourth lumbar vertebrae adjacent to the disc.

Tissue obtained by needle aspiration showed only fibrous tissue, a few large mononuclear leukocytes, masses of calcium, and occasional deposits of hemosiderin.

The symptoms subsided with recumbency and support.

Roentgenograms made six months later showed bony bridging between the involved vertebrae.

A diagnosis of typhoid osteomyelitis of the third and fourth lumbar vertebrae was made.

CASE 5.* G. G., white, thirty-four years of age, a registered nurse, a widow, and childless, was admitted to the Hospital in October 1933, complaining of severe pain of two months' duration in the lower cervical region and in the right shoulder.

Nine months previously, a microscopic diagnosis of squamous-cell carcinoma of the cervix, grade four, was made. Apparent local cure followed intensive radium treatment.

Roentgenograms showed a destructive lesion of the sixth cervical vertebra, most marked in the spinous process. No pathology was seen in roentgenograms of the chest, lumbar spine, or pelvis.

Tissue removed from the cervical spine by needle aspiration showed squamous-cell carcinoma.

The patient died two months later.

CASE 6. W. E. V., white, male, sixty-two years of age, a physician, was admitted to the Hospital in May 1934, because of low back pain which he attributed to a strain and subsequent chilling four weeks previously. The pain was constant, not relieved by recumbency, and opiates were required for rest.

Hypertension had been present for ten years. For two months preceding the onset of the pain the patient had been under the observation of an urologist because of prostatic hypertrophy which was considered to be of malignant origin.

Roentgenograms of the spine showed no pathology until three weeks after admission, when destructive changes involving the adjacent surfaces of the fourth and fifth lumbar vertebrae, with narrowing of the interspace, were seen.

Tissue removed from this area by needle biopsy consisted chiefly of dense fibrous tissue, containing a few lymphocytes and occasional deposits of hemosiderin.

FIG. 9

Case 6. W.E.V. Lateral roentgenogram, seven weeks after onset of symptoms, showing destructive changes involving fourth and fifth lumbar vertebrae adjacent to the interspace which is narrowed anteriorly.

* Patient of Dr. S. S. Marchbanks and Dr. A. M. Patterson.

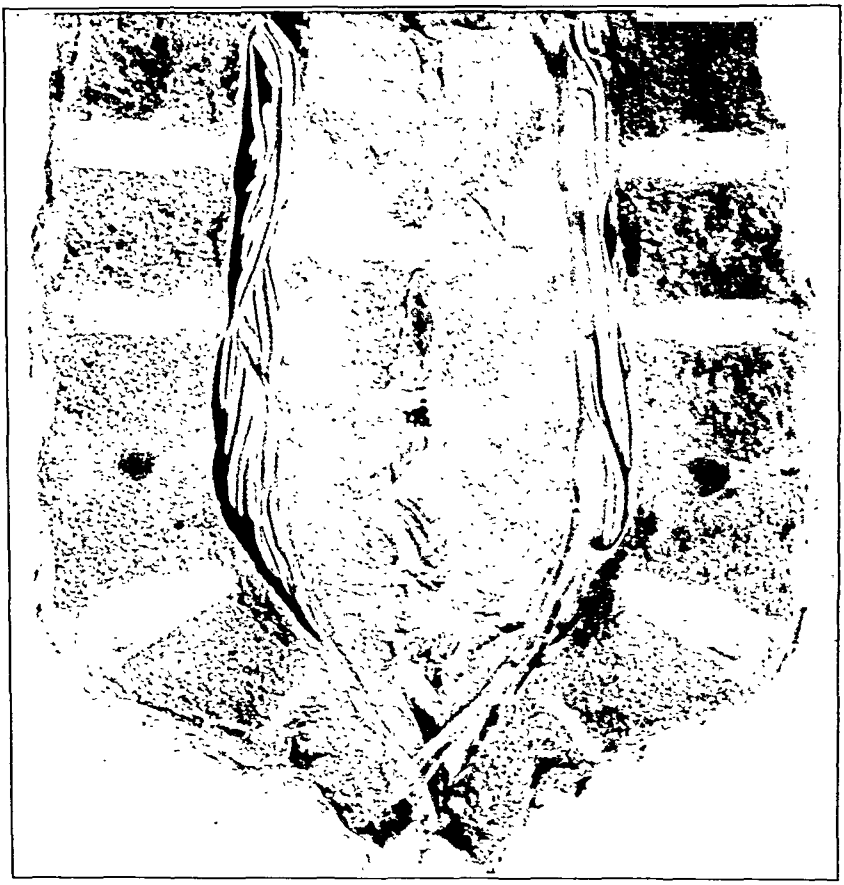

Fig. 10

Case 6. W.E.V. Specimen removed at post-mortem examination, six months after onset of symptoms. The intervertebral disc has practically disappeared with the exception of the nucleus pulposus which is intact. Bony union is present between the anterior portions of the involved vertebrae.

On June 5, 1934, a transurethral resection of the prostate was performed by Dr. G. M. Roberts, at which time a pus pocket under considerable tension was encountered. No neoplastic cells were found on microscopic examination.

The pain in the back gradually subsided with recumbency. Three months later the patient became ambulatory in a low back brace. He died of coronary embolus one month later.

At necropsy no evidence of malignancy could be found.

CONCLUSIONS

1. Tissue, or other material, obtained by means of needle (aspiration) biopsy from destructive spine lesions permits accurate diagnosis in many instances.

2. The cases reported show the value of this procedure in various types of destructive lesions.

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THE ADOLESCENT SACRO-ILIAC JOINT SYNDROME *

BY MARK H. ROGERS, M.D., AND EDWIN N. CLEAVES, M.D., BOSTON, MASSACHUSETTS

For many years, we have recognized that there is a group of patients of the adolescent age who show symptoms of stiffness of the low back and pain and tenderness over the sacro-iliac joint, often with sciatic pain and peculiar gait due to the loss of straight leg raising. Many of them so persistently fail to improve under routine treatment and the x-ray findings are of such a nature that the question is raised as to whether there is a real joint lesion, such as tuberculosis or infectious arthritis. Some years ago, when vigorous stretching and manipulation under an anaesthetic were routine forms of treatment, we became convinced that during adolescence such patients were often made worse by this method, since the rigidity and loss of motion persisted for months.

Sometimes the symptoms described appear in the rather stocky boy or girl, who is a little overweight and shows some of the characteristics of the Fröhlich type. It has been observed that such individuals may seem older than the average adolescent, yet they show definite signs that epiphyseal growth is still taking place. Sometimes they are considered good football material, especially for the line, on account of their weight, but some slight strain causes the symptoms to appear. The patients are then strapped, baked, and manipulated, and exercises are given. When there is no improvement and the x-rays suggest certain changes in one sacro-iliac joint, there comes the suspicion of bone pathology. This is the clinical type which we wish to discuss.

The physical findings are quite definite. In the severe types there may be a real protective list, away from the side of the symptoms. On standing, the motions are restricted,—forward bending is limited, while lateral bending is more restricted on one side than on the other. There is localized tenderness over the posterior ligaments of the sacro-iliac joint. With the patient in the recumbent position, the straight-leg-raising test is very much restricted and is accompanied by sciatic pain in the severe cases. On walking, there is the characteristic short-stepping gait on the side involved, which corresponds to the limitation of motion. The whole picture centers around one sacro-iliac joint,—tenderness, restriction of motion, and sciatic pain that may be quite disabling and that tends to recur on slight injuries or strain.

Children of school age do not ordinarily strain the low-back and sacro-iliac regions as readily as do older persons; therefore, when we have

* Read at the Annual Meeting of the American Orthopaedic Association, Philadelphia, Pennsylvania, June 6, 1935.

to deal with such a group of symptoms in the adolescent period, we begin to search for some underlying cause. In these cases it is difficult to trace the condition back to any one definite injury. Some slight strain during play, not sufficient at first to create a definite impression, is the common source. Once the symptoms start, however, repeated injuries aggravate the pain and stiffness.

We were very much interested in a study of the x-rays of this group of cases, to see whether we could point out any changes in the sacro-iliac joints that might be characteristic. This required a careful consideration of what the normal or average adolescent joint should show. We found that there has been very little work published concerning the epiphyseal-growth area in this region.

However, in Cunningham's Anatomy[1] there appears a description of the development of the sacrum, in which mention is made of the lateral epiphyses of the sacrum. These are small epiphyses which develop along the lateral margins of the sacrum. In observing a large number of pelves in children and adults, we were impressed by the width of the sacro-iliac joints in children as compared with those of adults. Roentgenograms of several individuals, taken both before and after adolescence, showed the wide sacro-iliac joints in childhood and those of normal width in the young adult.

The next problem was to determine what brought about the change. The lateral epiphyses mentioned by Cunningham suggested the answer. We began looking for these epiphyses in the roentgenograms. We have found them, we have seen them appear, and we have watched them fuse to the sacrum. To do this, we have taken stereoscopic plates of normal boys at six-month intervals. On other plates of pelves taken at random, we have seen these epiphyses in various stages of development. From our observations thus far, we believe these epiphyses appear during the fifteenth or sixteenth year, although we have seen them in one patient of thirteen years. In connection with this case, it is interesting to note that the other epiphyses were further advanced than the age of the individual would indicate. These epiphyses are usually fully developed and fused at seventeen or eighteen years of age.

We have also noticed that in some of the pelves one or both sacro-iliac joints may show a cloudy appearance, with some irregular areas of increased density at the site of the lateral epiphyses. In these cases, the joints may be slow in assuming adult appearance, or they may be very irregular, even suggesting pathological changes; yet, the patients have not complained of back symptoms.

Then we have seen the cases which we are now considering. The x-ray findings are variable and at times bizarre, so much so that some of these cases have been considered infectious arthritis, tuberculosis, or osteomyelitis. The joint space is often hazy and irregular; it may have a moth-eaten appearance. At the site of the lateral epiphyses there may be irregular areas of increased density. On account of the depth of the sacro-

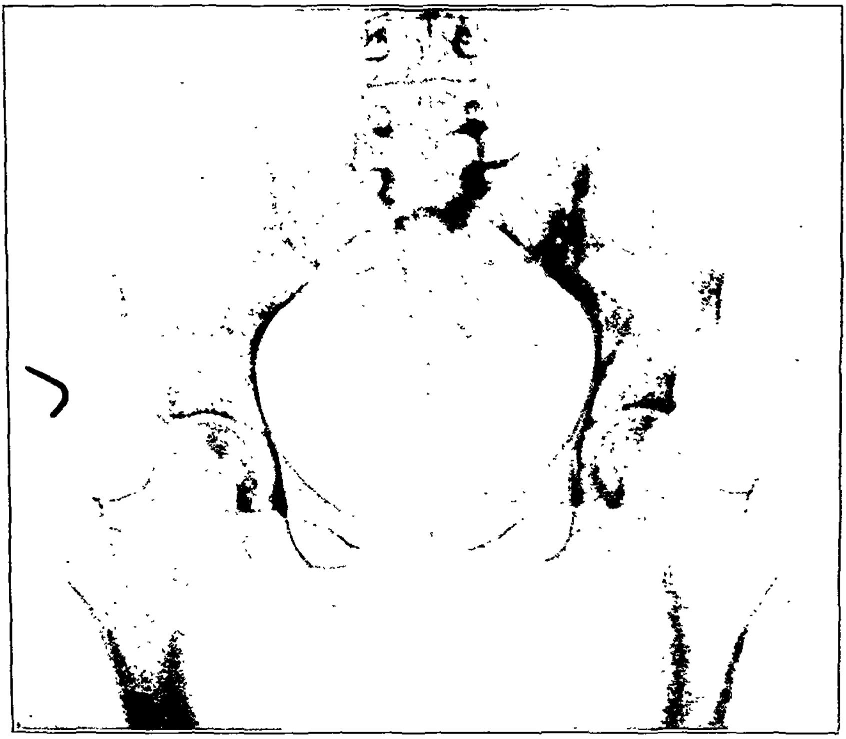

FIG. 1
Case 1. October 20, 1933.

iliac joints, the anterior margins may overlie the posterior margins in such a way as to confuse the picture and lead to a diagnosis of a destructive bone lesion, such as osteomyelitis or tuberculosis. However, there are no real areas of bone destruction, nor fusion of the joints, such as is seen in cases of infection or arthritis. Usually there is change in both sacro-iliac joints, but the joint on the side which is presenting symptoms usually shows the greater changes. It is interesting also to notice that the symphysis pubis is sometimes slightly out of alignment, suggesting abnormal mobility in one or both sacro-iliac joints.

These changes in the sacro-iliac joints resemble those noticed in Perthes' disease, Osgood-Schlatter disease, and other examples of epiphysitis or apophysitis. We feel that the condition which we have described as "adolescent sacro-iliac" is of a similar nature to that existing in these diseases, and should be differentiated from such lesions as tuberculosis, osteomyelitis, and arthritis.

We are reporting ten cases with a brief description of their clinical history which we believe represent a rather definite clinical entity. One of us (E. M. C.) has been interested in these from the roentgenographic standpoint. Some of these cases have been diagnosed as possible tuberculosis or severe infection.

FIG. 2
Case 2. October 31, 1931.

CASE REPORTS

CASE 1. J. A., a girl, aged fifteen, was referred by her physician on account of increasing low back pain with pain along the right sciatic nerve of two months' duration. An x-ray had been taken and the report read: "In the lower third of the right sacro-iliac joint there is definite evidence of pathology suggestive of and consistent with infection, probably tuberculous."

The patient was rather plump, short, and overweight. Examination revealed tenderness over the right sacro-iliac joint with loss of motion of the low back, a slight list, and very limited straight leg raising.

Treatment consisted of the simplest protective belt, rest from overexercise, and absolute attention to diet as in the obese child. There was continuous improvement.

The report on the x-rays taken six months later is as follows: "The right sacro-iliac joint shows irregular density on the sacral margin of the lower third of the joint. There are no areas of bone destruction and no evidence of fusing. There are several gas shadows directly in front of this area, which tend to confuse the picture. The left sacro-iliac joint appears normal. Diagnosis: Adolescent sacro-iliac."

CASE 2. M. W., a girl, aged seventeen, was first seen in September 1931, on her return from a girls' camp. During the summer, after any definite exercise, she had developed quite a severe backache in the right sacro-iliac region, with a list and definite sciatic pain.

The x-ray report reads: "The right sacro-iliac joint shows density along the sacral margin of the joint. The lateral epiphysis of the sacrum along the upper portion of the sacrum can be seen. It is slightly dense. There are no real areas of destruction, and no evidence of fusing. The left sacro-iliac joint appears normal. Diagnosis: Adolescent sacro-iliac."

The patient went away to school wearing a simple webbing belt. She grew rather rapidly and symptoms of acuteness returned on any violent exercise, but were controlled by rest, simple strapping, and a belt. A year later she entered a school of physical education and has had no return of symptoms.

In this case there was a possible focus of infection because the patient had been under treatment for sinus trouble. The clinical note read that we considered it to be probably the adolescent type of sacro-iliac joint, rather than a definite destructive lesion.

CASE 3. R. D., a boy, aged seventeen, weighing 240 pounds, was a good athlete in a preparatory school. During the football season, while playing tackle, he had hurt his back. In the winter he had slipped on the ice and had strained his back again. Both were minor injuries. Gradually all symptoms had become progressively worse and he was first seen and x-rays were taken when he had sciatic pain, a marked list, and pain at night. Symptoms and signs pointed toward the right sacro-iliac region.

The x-ray report reads: "The sacro-iliac joints appear wide, and lower left seems moth-eaten."

The symptoms persisted for a year, during which time the patient wore a brace and was kept out of active athletics. Two years later, when in college, he was examined again and was found to be free from symptoms.

CASE 4. E. S., a boy, aged sixteen, was seen in consultation because his symptoms persisted for four months in spite of various types of treatment. He was well built and played tackle on a high school football team. He had received an ordinary strained back,

FIG. 3

Case 5. October 30, 1934.

which had developed into a rather severe case of sciatic pain, with increase of symptoms on any exercise.

Examination showed a rather rigid low back, the symptoms centering chiefly around the right sacro-iliac joint, and absolute loss of straight leg raising. The x-ray showed a characteristic haziness of the joint.

Treatment consisted of physiotherapy and exercises in an attempt to increase the amount of motion. Considerable pressure was brought to bear upon those taking care of the case to hurry his recovery by more treatment and even forcible manipulation under an anaesthetic. Our advice, however, was to consider it an adolescent affair, to let up on treatment, to have the patient wear a simple brace, and not to permit him to engage in athletics.

Case 5. P. K., a boy, aged fifteen, one of the milder cases, was seen early in the course of his trouble, because his mother had been through a long siege of severe sacro-

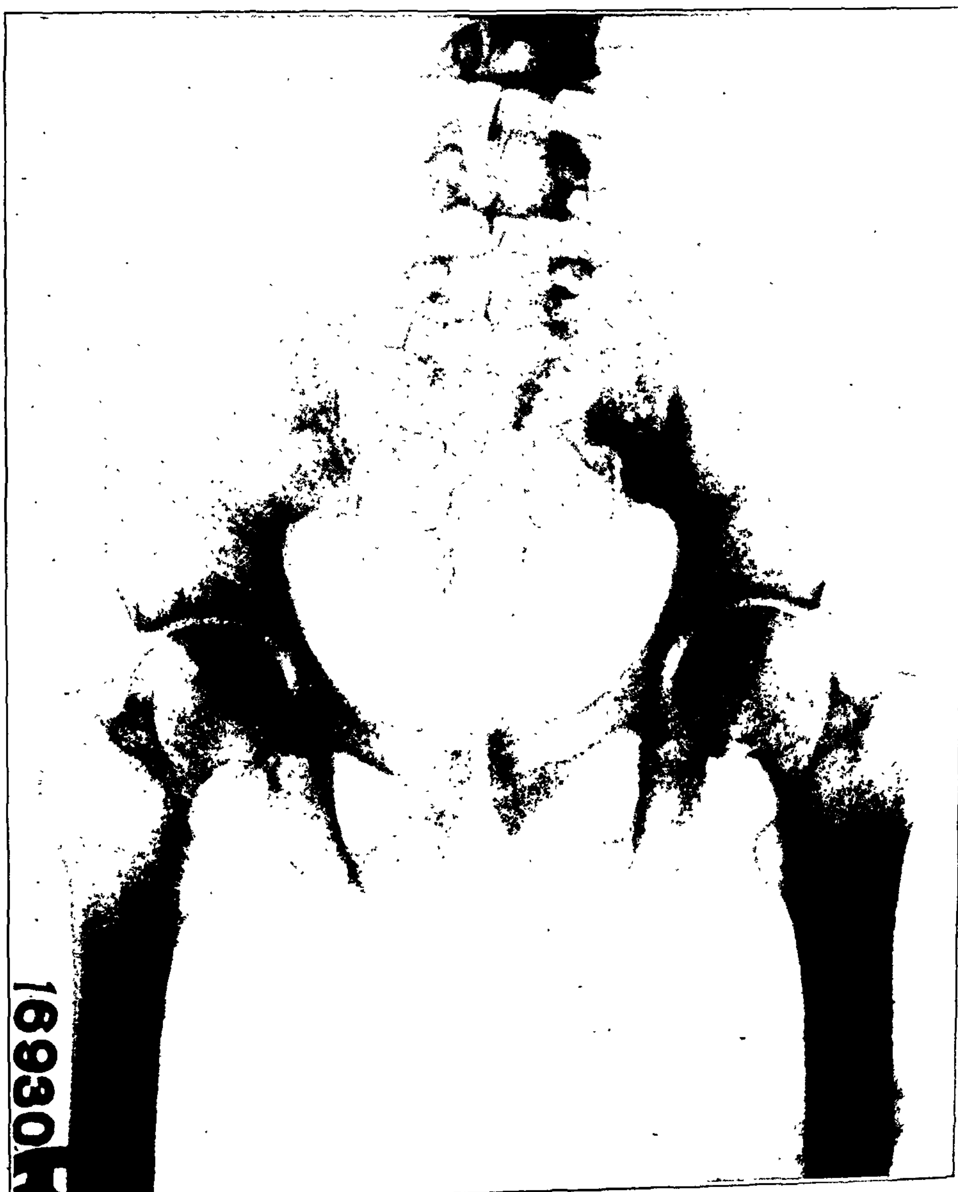

Fig. 4
Case 6. July 12, 1934.

Fig. 5
Case 7. November 1, 1934.

Fig. 6
Case 9. November 6, 1934.

FIG. 7
Case 10. January 16, 1934.

iliac strain with sciatic pain three years before and because she had noticed that the boy was limping and walking with a short gait, due to limited straight leg raising. The trouble had started while he was playing football and had become so acute during the month preceding examination that any quick motion caused pain.

Examination showed a well built, stocky type of boy, with quite limited straight leg raising. The x-ray report states: "The sacro-iliac joints appear wide and are not clear-cut. The right looks irregular, especially in its central portion. We believe the appearance of the sacro-iliac joints, especially the right, is due to an epiphyseal condition such as is seen in adolescence."

This patient received very little treatment and his symptoms were relieved by simple protection. The condition was explained to his mother and he is out of athletics for the time being.

CASE 6. F., a boy, aged nineteen. The patient was first seen at the age of seventeen, when he entered college. He was overweight, slightly knock-kneed, and suggested the Fröhlich type. He complained of being tired and moderate backache and was urged to remain under the care of a medical man for his general condition.

During the summer previous to examination, probably following rather violent exercise, he had developed a severe sacro-iliac sciatica, which had kept him in bed for a month. Any motion or attempt at sitting up was very painful.

This case is not quite typical in that the x-rays show a definite congenital malformation,—a fused large transverse process on the side of the sciatic symptoms. In addition to this congenital malformation, it is quite clear that the epiphyses of the ilium are still showing and the sacro-iliac joint on the right side still shows a typical fuzziness, as seen in the younger cases. The question arises as to whether the entire

sciatic group of symptoms were due to the large transverse process or to the delayed growth in adolescence.

CASE 7. C., a boy, aged fifteen, was working as an order boy in a grocery store. He had developed a back strain in August 1931 and had been out of work for a month. In October 1931 the same symptoms had returned and he had been under constant treatment (chiefly physiotherapy) for six months at an Insurance Clinic.

At the end of eight months, the patient still showed limited straight leg raising and stiffness, and there was tenderness over the region of the left sacro-iliac joint. The boy was of the adolescent type with large epiphyses and our recommendation was that he should not go back to heavy lifting.

In 1934, at the age of seventeen, the patient was again seen because of recurrence of symptoms while working for another concern. The x-ray report is as follows: "The lateral epiphyses of both sacro-iliac joints can be seen unusually well. In them are irregular areas of increased density. This gives an irregular fuzzy appearance to the joints. However, there are no areas of destruction, no areas of atrophy in the sacrum or ilia, and no evidence of fusing of the joints. The appearance of the lateral epiphyses suggests an epiphysitis. Diagnosis: Adolescent sacro-iliac."

This was an important case industrially on account of the expense involved and the question of liability. The x-ray at the age of fifteen was reported negative by another roentgenologist, but it was recognized at that time in our report as typical of the type under discussion.

CASE 8. A boy of sixteen was seen in consultation because of a slow recovery from a rather severe strain of the right sacro-iliac joint, with sciatic symptoms. He was a well built, heavy type of boy, a good athlete, and his father was anxious for him to make a good record in high school football. For two months he had been under fairly constant treatment, chiefly by physiotherapy. He still showed a good deal of restriction of motion in the low back, especially the so called tight hamstring muscles, and it was a question whether or not more vigorous physiotherapy should be employed.

The x-rays showed the same fuzziness about the sacro-iliac joints as did those in the other cases. They are not reproduced for this paper. We recognized that the patient was an adolescent and that he needed not more treatment, but less activity. Although it was hard to convince the parents, this procedure was carried out.

CASE 9. H. G., a girl, aged fourteen. This patient's case is reported chiefly on account of the x-ray findings. She does not present symptoms localized in one sacro-iliac joint. She is a rapidly growing girl, showing a slight posteral curvature, and has been complaining of backache for four months.

The x-ray report is as follows: "The left ramus of the pubes is higher than the right. The sacro-iliac joints are still in the process of development. The epiphyses can be seen on the lateral margins of the sacrum. The epiphyses show irregular areas of increased density. There are more changes on the left side than on the right. The appearance of the sacro-iliac joints suggest epiphysitis."

CASE 10. G. P., a male, aged twenty, was seen in January 1934. He was slender and tall, with relaxed posture. For seven months he had been complaining of a constant pain in back of the left hip. He had developed more pain on walking and exercise. He had no definite sciatic pain except some referred pain to the buttocks.

Examination showed definite tenderness over the left sacro-iliac joint and some tenderness over the right. The tuberculin test was strongly positive.

An x-ray report from another office stated that the left sacro-iliac joint showed a condition consistent with tuberculosis. Dr. Cleaves' description is as follows: "The left ramus of the symphysis is slightly higher than the right. The left sacro-iliac joint shows some marginal density, especially at the lower portion of the joint. The joint has a somewhat irregular appearance. This is more apparent than real, because of several small

gas shadows which are in front of the joint. There are no areas of bone destruction, and no evidence of fusing of the joint. The right sacro-iliac joint shows a somewhat similar appearance in its central portion. We believe that the condition in the sacro-iliac joints is probably of the nature of an epiphysitis."

The patient has been followed for the last year without any signs pointing toward a progressive disease such as tuberculosis, and has been treated as if this were a case of epiphysitis of this joint.

CONCLUSIONS

The x-ray reports of these ten cases have come originally from four different offices, and they suggest that during the adolescent period there may be confusion as to diagnosis.

Clinically, we are quite sure that there is a tendency to establish a wrong diagnosis and also to carry out too vigorous treatment which only perpetuates the symptoms. This was so in certain epiphyseal conditions of the hip, knee, and spine until it was recognized that injuries and trauma to the epiphysis should be treated by rest. This was also true with reference to the tibial tubercle.

In regard to the development of the epiphyseal centers in and around the sacro-iliac joint, we have not been able to find any extensive work that gives a good description of this joint; therefore, our work is necessarily a clinical description, using the broad term "the adolescent sacro-iliac-joint syndrome".

1. Cunningham, D. J.: Text-Book of Anatomy. Ed. 2. p. 94. New York, Wm. Wood & Co., 1905.

THE EFFECT OF FRACTURES ON BLOOD SUGAR *

BY ROBERT V. FUNSTEN, M.D., UNIVERSITY, VIRGINIA

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The author's attention was first called to the influence of fractures on sugar metabolism by the following case:

A young lady, twenty-two years of age, was admitted to the University Hospital on July 21, 1933, with a comminuted fracture of the left tibia. The fracture was reduced and a cast applied.

This patient gave a history of having been a diabetic for eleven years, but for the past eight years she had been sugar-free. She had taken insulin from time to time and had watched her diet to a certain extent.

Immediately following the injury, a sufficient amount of sugar was excreted in the urine so promptly that reduction took place with one drop of urine. Four days after admission, the patient became comatose and the blood sugar was found to be 400 milligrams per 100 cubic centimeters of blood, the acetone 3 plus and diacetic acid 2 plus. She was given orange juice and treated with insulin—twenty-five units every two hours. Within twenty-four hours the blood sugar had dropped to 100 milligrams per 100 cubic centimeters, but there was still present acetone 3 plus and diacetic acid 3 plus. The patient was no longer comatose, and was placed on a diet containing ninety grams of carbohydrate, sixty grams of protein, and 100 grams of fat. She was given ten units of insulin three times a day. The acetone and diacetic acid continued to be present in the large quantities mentioned. The intake of insulin was gradually increased until, eleven days after admission, the patient was receiving a total of 135 units a day.

However, twelve days after admission, her blood sugar was 351 milligrams per 100 cubic centimeters and the urine contained only 2 plus acetone and no diacetic acid. Improvement continued and twenty-two days after admission the insulin had been gradually reduced to eighty-one units a day. (See Table I.)

At the time of her discharge, twenty-five days after admission, the blood sugar had returned to 114 milligrams per 100 cubic centimeters and the diabetic condition seemed to be controlled.

The patient recovered entirely from the fracture and from the diabetic attack, and returned to her work. Eleven months later she was again admitted to the Hospital with a Colles' fracture, the result of a severe fall. At this time the blood sugar again became elevated to 240 milligrams per 100 cubic centimeters, but returned to normal very promptly when the patient was put temporarily on a restricted diet and given ten units of insulin three times a day.

After both of these fractures it was possible for the patient to return to her normal use of insulin after about thirty-five days.

In addition to this case, the blood sugar in eleven other fracture cases has been followed. In some there was extensive trauma, but in others comparatively little. In no case was there any previous or family history of diabetes. In one of these cases the patient developed active hyperglycaemia and hyperglycosuria.

This patient, a woman seventy-four years of age, was admitted to the Hospital on September 17, 1934, following an automobile accident. She had received extensive

* Presented at the Annual Meeting of the American Academy of Orthopaedic Surgeons, New York, N. Y., January 15, 1935.

TABLE I

Case 1

Date	Blood Sugar Mg. per 100 c. c.	Urine Sugar	Urine Acetone	Urine Diacetic Acid	Treatment for Diabetes
July 21, 1933		1 drop			
July 25, 1933	400	1 drop	+++	++	Orange juice and insulin.
July 26, 1933	100	1 drop	+++	+++	Carbohydrate, 90 grams; protein, 60 grams; fat, 100 grams. Insulin, 10 units before meals.
July 29, 1933		2 drops	++++	+++	Carbohydrate, 90 grams; protein, 60 grams; fat, 100 grams. Insulin: 30 units before breakfast 25 units before dinner 25 units before supper 10 units at bedtime — 90 units—Total
Aug. 1, 1933		1 drop	++		Carbohydrate, 90 grams; protein, 60 grams; fat, 100 grams. Insulin: 135 units—Total
Aug. 4, 1933	243	1 drop			Carbohydrate, 90 grams; protein, 60 grams; fat, 100 grams. Insulin: 105 units—Total
Aug. 8, 1933	348	1 drop			Carbohydrate, 90 grams; protein, 60 grams; fat, 100 grams. Insulin: 68 units—Total
Aug. 12, 1933	114	10 drops			Carbohydrate, 90 grams; protein, 60 grams; fat, 100 grams. Insulin: 81 units—Total

lacerations about the scalp and left ankle, a comminuted fracture of the right humerus, and a comminuted fracture of the right femur. The wounds were closed and the fractures were reduced or immobilized immediately.

The following morning the blood sugar was 364 milligrams per 100 cubic centimeters. The patient was placed on a controlled diet and given ten units of insulin before meals. Four days after admission, the blood sugar had returned to 154 milligrams per 100 cubic centimeters and the amount of carbohydrate was slightly increased. The diet was then allowed to remain the same, but the insulin was gradually discontinued.

The fractures healed without complications and at the time of the last examination, four months following injury, the patient had returned to her usual diet without any return of glycosuria. (See Table II.)

Only two of the remaining ten cases studied showed any appreciable

TABLE II
CASE 2

Date	Blood Sugar *Mg. per 100 c. c.*	Urine Sugar	Urine Acetone	Urine Diacetic Acid	Treatment for Diabetes
Sept. 17, 1934		1 drop			
Sept. 18, 1934	364	1 drop	+		Carbohydrate, 80 grams; protein, 60 grams; fat, 100 grams. Insulin, 10 units before meals.
Sept. 21, 1934	154		+		Carbohydrate, 100 grams; protein, 60 grams; fat, 100 grams. Insulin, 10 units before meals.
Sept. 24, 1934					Carbohydrate, 100 grams; protein, 60 grams; fat, 100 grams. Insulin, 5 units before meals.
Oct. 10, 1934					Carbohydrate, 100 grams; protein, 60 grams; fat, 100 grams. Insulin, 5 units before meals.

elevation in the blood sugar, and the blood sugar did not seem to have any relation to the severity of the injury, age, amount of compounding, or the method of treatment. (See Table III.)

Apparently the increase in blood sugar takes place almost immediately after fracture in those patients which are susceptible to blood-sugar disturbance. The effects seem to last for about a month.

Pollock [1], working at The Mayo Clinic, has emphasized the influence of bone fractures on the insulin requirements in diabetic patients and has reported three typical cases. He discusses the causes of such influence, mentioning phosphate metabolism, tissue trauma, and fat emboli in the pancreas. He also draws attention to the scant literature on the subject.

Konjetzny and Weiland [2] report eighty-three cases in which 48.1 per cent. of the patients had neither spontaneous nor alimentary glycosuria following fractures. Transient glycosuria was found in 40.9 per cent., and 3.6 per cent. were already diabetic. Thirty-one out of thirty-six patients whose blood was tested showed some degree of hyperglycaemia.

Hundsdörfer [3] found several patients who showed a transitory hyperglycaemia following fractures.

The series of cases presented in this paper, and illustrated with tables, is far too small to draw conclusions as to the percentage of fracture cases which show hyperglycaemia. It has impressed the writer, however, with the necessity of taking the matter into consideration in the treatment of diabetic and near diabetic patients with fractures.

TABLE III

Cases 3 to 12 Inclusive

	Name, Age, Sex, and Case No.	Diagnosis	Laboratory Studies: Urine	Blood Sugar: *Date*	Blood Sugar: *Mg. per 100 c. c.*	Treatment
Admitted— Sept. 25, 1934 Discharged— Oct. 22, 1934	A. N., 65 years. F., colored 112507	Fracture of right femur. Asthma.	Negative	Sept. 28, 1934	91.0	Fracture reduced by Russell's traction. Cast.
Admitted— Oct. 7, 1934 Discharged— Oct. 17, 1934	W. N. L., 52 years. F., white 112767	Wounds. Laceration of face. Compound comminuted fracture of left tibia and fibula. Concussion of brain.	Negative	Oct. 10, 1934 Oct. 13, 1934 Oct. 15, 1934 Oct. 16, 1934	133.0 86.0 81.0 114.0	Open reduction of fracture. Débridement and suture of laceration of face. Cast.
Admitted— Oct. 8, 1934 Discharged— Oct. 13, 1934	S. W. F., 39 years. F., colored 112796	Fracture of radius and ulna.	Negative	Oct. 9, 1934 Oct. 10, 1934 Oct. 11, 1934 Oct. 12, 1934	105.0 111.0 108.0 111.0	Reduction of fractures. Cast.
Admitted— Sept. 27, 1934 Discharged— Oct. 26, 1934	S. C. H., 6 years. F., white 112584	Fracture of right femur.	Negative	Sept. 29, 1934	78.0	Bryant's traction, Russell's traction, and hip spica.
Admitted— Aug. 29, 1934 Discharged— Nov. 1, 1934	J. C., 40 years. M., white 111996	Comminuted fracture of right tibia.	Negative	Sept. 2, 1934	114.0	Thomas splint, skeletal traction, and cast.
Admitted— Nov. 12, 1934 Discharged— Nov. 13, 1934	M. O., 55 years. F., white	Ununited fracture of tibia and fibula.	Negative	Nov. 13, 1934	116.0	Closed reduction. Cast.
Admitted— Nov. 16, 1934 Discharged— Nov. 20, 1934	T. C., 21 years. F., white 113540	Compound comminuted fracture of tibia and fibula.	Negative	Nov. 17, 1934	93.8	Open reduction of fracture and débridement of wound. Cast.
Admitted— Nov. 17, 1934 Discharged— Nov. 20, 1934	W. E. K., 54 years. M., white 113554	Comminuted fracture of radius. Simple fracture of ulna.	Negative	Nov. 18, 1934 Nov. 19, 1934 Nov. 20, 1934 (No change in temperature or pulse.)	119.6 133.0 129.0	Closed reduction of fractures. Cast.
Admitted— Dec. 8, 1934 Discharged— Dec. 15, 1934	S. H., 22 years. M., white 113921	Compound fracture of tibia and fibula. Lacerated wounds of scalp. No history of unconsciousness.	Negative	Dec. 19, 1934	118.0	Débridement. Open reduction of fracture.
Admitted— Dec. 20, 1934 Discharged— Dec. 21, 1934	D. P., 29 years. F., white 114102	Pott's fracture.	Negative	Dec. 21, 1934	115.0	Closed reduction. Cast.

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SLIPPING PATELLA OR RECURRENT DISLOCATION OF THE PATELLA *

BY FRANK R. OBER, M.D., BOSTON, MASSACHUSETTS

Slipping patella is a very disabling condition for which many remedies have been suggested. It may be unilateral or bilateral. Since Goldthwait described his operative method for treatment of this condition, many other procedures have been published,—namely, those by Gallie, Soutter, Mouchet, Fitchet, Brackett, and Albee.

Several years ago, while an operation was being performed on a child with a congenitally displaced patella, it was found that the Goldthwait operation was not sufficient to hold the patella in its normal position. The patella was found to be situated beneath the iliotibial band and all its structures were connected with the band so that it was impossible to replace the patella until it was freed from the iliotibial band. The fact that this congenitally displaced patella was so situated led the author to the belief that, in the case of a recurrent dislocation, there was an abnormal relationship between the iliotibial band and the patella. In other words,

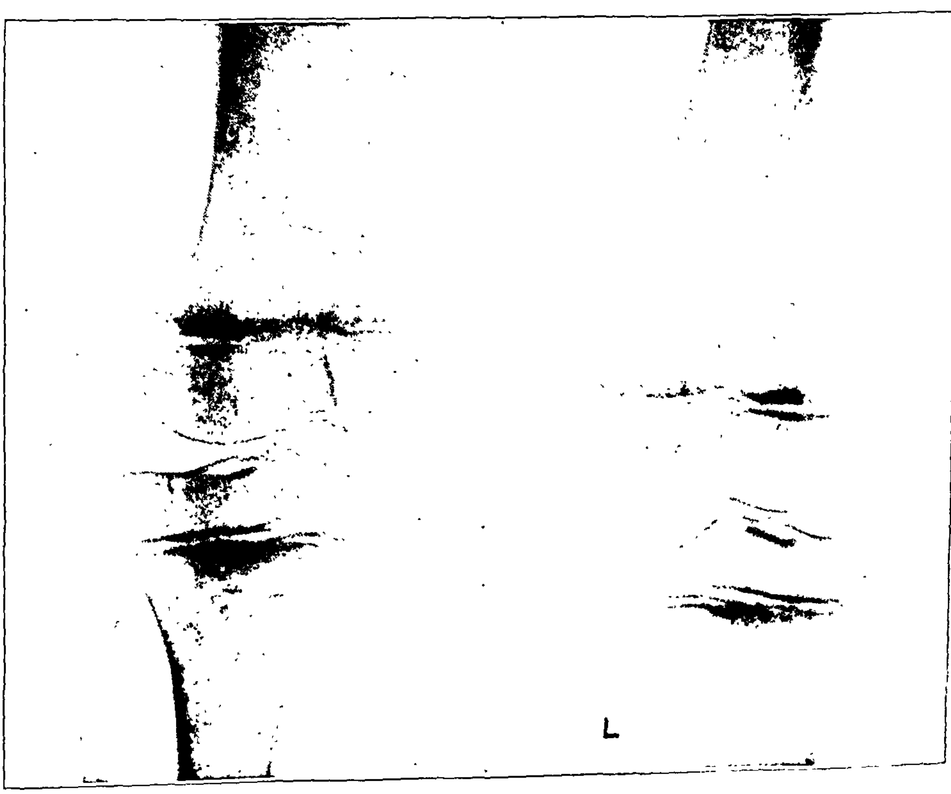

FIG. 1

Roentgenograms showing patellae which are dislocated laterally.

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, New York, N. Y., January 15, 1935.

FIG. 2
Roentgenograms of the patellae just before slipping takes place.

the condition was a mild degree of congenital displacement of the patella.

PATHOLOGICAL ANATOMY

The displaced patella usually dislocates laterally. (See Figure 1.) As a result, it is often higher above the knee joint than is the normal patella, so that it does not have the support of the external condyle that it should have and rides laterally over the rounded edge of the femur.

There is a band leading from the lateral border of the patella beneath the fascia lata and inserted in the deep substance of the iliotibial band. When this band has been divided, there is a mass of areolar tissue beneath it. Upon removal of this tissue, there is found a second band, about one inch wide, which extends from the posterolateral border of the patella to the intramuscular septum at the anterior aspect of the biceps tendon. (This is seen in normal knees, but is thinner than in the cases of slipping patella.)

A knock-knee condition is often associated with recurrent dislocation of the patella.

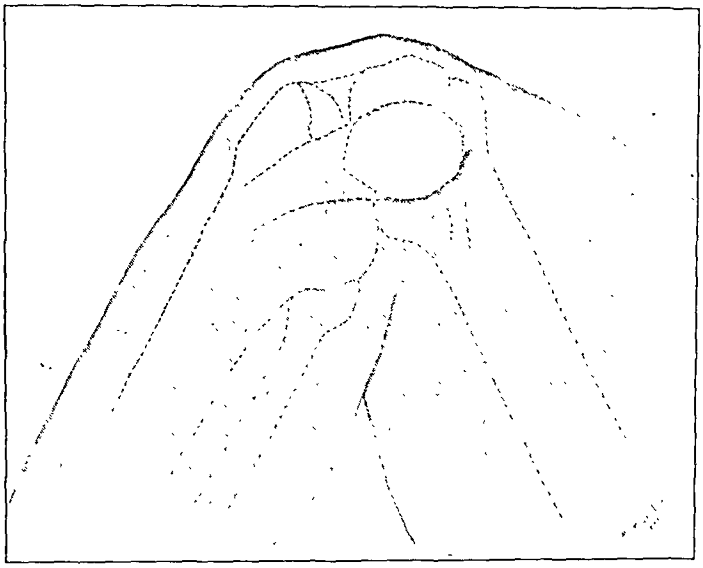

Fig. 3

Drawing to illustrate appearance of the patella just before operation.

SYMPTOMS

Dislocation of the patella usually occurs suddenly while the knee is flexed and the patient is walking, and results in a fall. Patients subjectively aware of their condition walk in a fashion so as to prevent dislocation. When dislocation occurs, it is attended with more or less discomfort. It is possible for the examiner to push the patella laterally off the femur and it is easily replaced. If the patient is placed on his sound side and the knee is flexed at a right angle and the thigh abducted, with the thigh in the vertical plane of the body, in many instances the iliotibial band will displace the patella as the thigh adducts to the examining table.

TREATMENT

The best treatment is operative, and the following procedure has been carried out by the author:

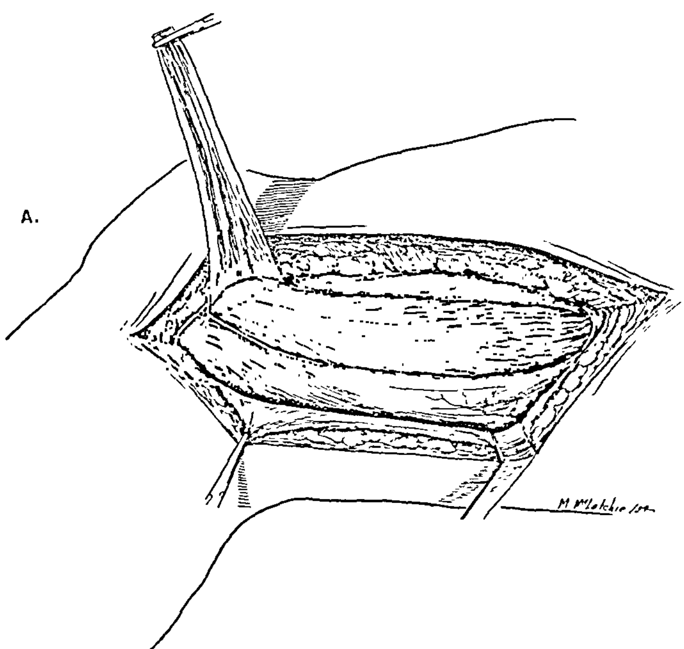

Fig. 4

Showing the iliotibial band freed from its bed down to the patella.

1. An incision, six or seven inches long, is made over the lateral aspect of the thigh, beginning at a point opposite the apex of the patella and exposing the iliotibial band.

2. A second incision is made along the anterior and posterior margins of the iliotibial band, so that a strip, six inches long and one-half an inch wide, is made from below upward. The

strip is divided at the upper end of the wound and dissected free from its bed downward, leaving the lower end attached to the surrounding structures.

3. The superficial and deep bands described are divided transversely; care should be taken not to enter the knee joint.

4. Another incision, three inches long, is made over the medial border of the tibia, extending downward from the inner tuberosity and exposing the medial border of the bone and the insertion of the hamstring.

5. A tunnel, one-half an inch long, is made through this part of the bone.

6. A tunnel is made beneath the aponeurosis of the patella, entering from the upper wound and coming out through the lower.

7. The flap of the iliotibial band is passed down through this tunnel, brought from within outward through the groove which was made in the tibia, and sutured on its end to the surrounding structures. The fascial strips should be drawn as tightly as possible. After the suturing has been done, it will be found that it is impossible to dislocate the patella.

This operation relieves the pathological anatomy and supplies an extra patellar tendon, the resultant force of which maintains the patella in its normal position.

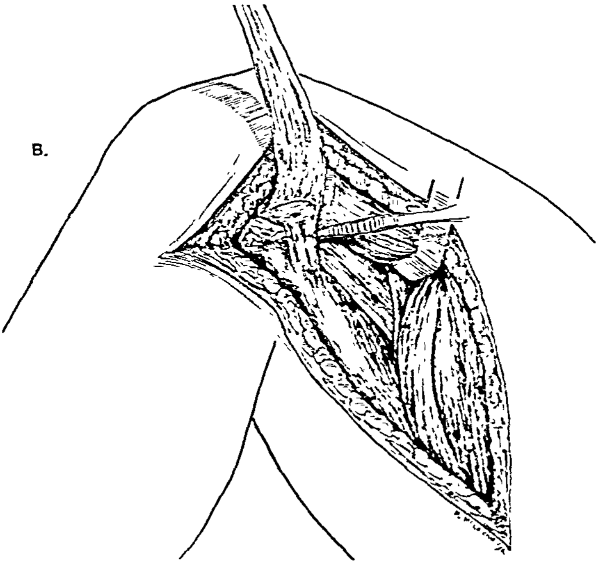

FIG. 5

Showing the iliotibial band freed and the transverse band extending from the inferior lateral aspect of the patella to the biceps tendon. There is always another band superficial to this in such cases, but this band does not show in the drawing.

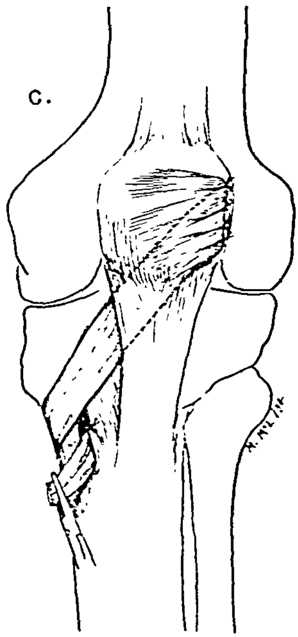

FIG. 6

Drawing showing the iliotibial band passed beneath the aponeurosis, and the method of suturing it to the medial aspect of the tibia.

CASE REPORTS

Case 1. P.C., a white female, aged nine years, was seen on May 4, 1923.

The patient had had frequent attacks of slipping of the patella, causing her to fall. The knees showed slight knock knee, the fat pads were thickened, and there was moderate atrophy of the thigh muscles, especially of the vasti. She was treated conservatively until May 1, 1929.

On that date, an operation was performed on both knees. A lateral incision, five inches long, was made over the knee, exposing the lateral border of the patella and the iliotibial band. A strip of this band, one-half an inch wide, was freed from above downward to the tibia, leaving the lower end attached. The patella was found to be held laterally by this band and, as soon as it was freed, the patella could be placed in its normal position. A second incision was made over the medial border of the tibia, exposing the bone at the level of the tibial tubercle. The border of the tibia was tunneled downward and the patella was tunneled from the top. The fascial flap was passed through both the patellar and tibial grooves, drawn tight, and sutured to the bone. A similar procedure was carried out on the opposite side. Plaster casts were applied.

On September 16, 1929, examination showed an excellent operative result. It was impossible to slip either patella laterally.

Case 2. B.B., a white female, aged six years, was seen on October 12, 1927. Examination revealed bilateral congenital club-foot and congenital dislocation of the right patella.

On October 14, 1927, a plastic operation, using the Goldthwait procedure, was performed on the right patella. A medial incision was made over the head of the right tibia, exposing the ligamentum patellae. Half of this ligament was split off and the lower end implanted into the medial border of the tibia; the redundant capsule was plicated.

X-rays, taken on January 26, 1929, showed dislocation of the left patella.

On February 6, 1929, the left knee was operated upon and the patella was found to be attached to and practically in the iliotibial band. As soon as the fascia was freed from the patella, it was found that the patella could be easily replaced. A tunnel was made through the patella and a strip of the iliotibial band was threaded down through this groove. The fascia was sutured to a bony tunnel on the medial border of the tibia opposite the tibial tubercle and also to the patella, care being used to keep this strip tight in order to prevent the patella from slipping at its proximal end. (See Figure 6.)

The patella remained in position on knee flexion.

Case 3. H.J., a white female, married, was seen on June 24, 1932, complaining of slipping of the right patella. She had had trouble with the right knee since childhood. Examination showed lateral mobility, moderate atrophy of the quadriceps, slight knock knee, and arthritic changes in both joints.

The patient was treated conservatively until April 28, 1934, when an operation was performed. The usual medial incision was made over the tibia and lateral aspect of the patella, exposing the iliotibial band. The lateral aspect of the patella was nearer to this band than normally and, when the knee was flexed, the tight band pulled the patella laterally. The iliotibial band was dissected off as a flap, one inch wide, from above downward to a point opposite the apex of the patella. When this flap was freed, a dense fibrous band, one inch wide, was found beneath it, extending from the anterolateral aspect of the patella to the intermuscular septum. Beneath this was a mass of areolar tissue. The band and the fatty tissue were removed and under this was found a second fibrous band extending from the posterolateral aspect of the patella to the intermuscular septum. This was removed without entering the joint. As soon as these bands were freed, it was possible to place the patella in its usual position. The operation was finished as described in the other case.

At examination on September 17, 1934, the patella did not slip laterally and the knee was in good condition.

Case 4. R.H., a white female, aged twenty-three years, single, was seen February 28, 1934, complaining of slipping of both patellae. The patient had had sudden attacks

of severe pain in both knees, usually followed by a fall to the ground. Examination showed slipping patellae, which could be easily dislocated manually, and knock knee.

On April 21, 1934, an operation similar to those described in the other cases was performed and a like pathological condition was found. Result: excellent.

Case 5. H.MacD., a white female, aged thirty-two years, complained of slipping of the left patella. Since the age of ten, she had had recurrent attacks and the patella had been easily dislocated.

On July 9, 1934, an operation was performed; the procedure and pathological findings were similar to those of the other cases reported. Result: excellent.

CONCLUSIONS

1. Slipping patella is probably a slight degree of congenital dislocation of the patella.
2. The pathology in the last three of the author's cases was practically the same.
3. The operation described should free the patella from an abnormal bed and allow it to be kept in the intercondylar space.
4. The operation is simple and the convalescence is short. The patients are permitted to walk in three to four weeks.

THE CORRECTION OF RACHITIC DEFORMITIES BY PRELIMINARY DECALCIFICATION *

BY HARRY FINKELSTEIN, M.D., F.A.C.S., NEW YORK, N. Y.

Notwithstanding the fact that great strides have been made in modern prophylactic treatment, rachitic bone deformities are still quite prevalent and constitute a large proportion of the cases treated in the average orthopaedic clinic.

The present accepted treatment of rachitic deformities may be briefly summed up as follows: During the *acute stage,* antirachitic therapy and recumbency are indicated; if *subacute,* expectant, manipulative, or mechanical methods should be applied to improve the deformity; and only when the *process is arrested* and the bones hardened are operative measures advisable. Unfortunately, under such therapy a considerable proportion of these patients reach advanced childhood with residual bone deformities of varying degree.

Delahaye has tabulated 898 cases, treated at the Maritime Hospital from 1923 to 1930, of which 118 presented fixed deformities of the lower extremities sufficiently marked to require operative intervention. The findings in these 118 cases were as follows: sixty-five patients were operated upon for genu valgum, unilateral or bilateral; ten for genu varum, unilateral or bilateral; twenty-seven for unilateral or bilateral curves of the tibial diaphyses; and sixteen for complex and multiple deviations of the femur and tibia.

Although the simple cases respond readily to osteotomies, the complicated group often present insurmountable difficulties in that the correction of one distortion may aggravate the adjacent curves and it is not unusual for a severe case to require six or more osteotomies before a correction is obtained, thereby constituting a severe strain on the patient's vital capacity, not to mention the prolonged period of treatment and hospitalization required.

There is, of course, the possibility that our accepted theory of postponing operative intervention until the rachitic process has subsided, with resulting bony eburnation, may be just as erroneous as was the former practice of postponing for several years the correction of club feet and congenital dislocations of the hips.

It is not at all surprising, therefore, that attempts have been made in recent years to attack these deformities at an earlier date in the hope of preventing subsequent complications. Of these attempts, the method suggested by Rabl is rather ingenious. After preliminary softening of the deformed bones by the internal use of ammonium chloride (two-tenths of a gram per day per kilogram of body weight in 4 per cent. solution) and

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, New York, N. Y., January 16, 1935.

the application of a tight rubber bandage to the deformed limb to produce venous congestion, he corrects the deformities manually under narcosis. During the preliminary treatment, all antirachitic therapy is discontinued. Immediately after the redressement, general antirachitic treatment is energetically instituted. Rabl considers this method as being absolutely indicated in children under two years of age.*

The objection to this form of treatment is obvious. There is no known internal decalcifying agent which has a selective local action. The decalcifying process, following the ingestion of certain foods or internal medications, is of necessity general in character and the danger of softening other bones throughout the body is too great to warrant its employment.

It is, therefore, reasonable to assume that the method of choice should be one that is capable of producing local softening without detrimental general effects. The simplest and safest known method of producing local decalcification is by absolute immobilization of the part (preferably in a plaster cast) and disuse. This fact has been definitely demonstrated, both experimentally and in practice, by various observers. Studies were undertaken on laboratory animals by Grey and Carr and also by Allison and Brooks. They sectioned the motor nerves of one extremity, thus producing paralysis of the limb, and applied plaster casts to the opposite extremity as controls. They concluded that the changes which occurred in the bones of the encased normal limb were identical with those occurring in the paralyzed extremity, and that there was no discernable difference between the disuse caused by immobilization in a plaster cast and that caused by section of the motor nerves of the part.

Key, Fischer, and Elzinga conducted a series of experiments on normal human extremities and concluded that:

1. Immobilization of an extremity leads to atrophy of the bones of that extremity.
2. This atrophy can be detected in roentgenograms taken four weeks after the immobilization has begun.
3. The atrophy is progressive, and, if an extremity with atrophic bones is immobilized, further atrophy of these bones may be expected.
4. Operative or accidental trauma does not appreciably increase the atrophy incident to the immobilization.
5. The presence of a pyogenic infection in the extremity appears to increase the local atrophy of the bones.
6. The growth and formation of new bone may occur simultaneously with local atrophy of a given bone.

In describing a new procedure for correcting anterior distortion of the neck of the femur in cases of congenital dislocation of the hip, Krida stated that, after three months of plaster immobilization of the reduced hip in internal rotation, he was able to perform a manual osteoclasis of the

* Kraus reported a mortality in a child treated by Rabl's method, attributing it to fat embolism.

femur in the supracondylar region without difficulty, owing to the extreme atrophy of the bones from disuse. He reported forty cases of anterior distortion in which manual osteoclases were performed.

R. Charry suggested the possibility of preventing or correcting deformities in the course of the evolution of rickets, while the dietetic and medicinal treatments were being carried out. Patients, eighteen to twenty months old, were immobilized in the supine position in plaster casts which were changed every two months. If patients could be kept in a recumbent position without casts, ultraviolet rays were applied and saline baths given. Where deformities of the tibia already existed, plaster was applied and changed every three weeks. If the bone was flexible, Charry performed a so called subosteoclasis, correcting the deformity without fracturing the bone. If the bone had lost its flexibility, a manual osteoclasis was performed. When the bone was very hard and could not be fractured, plaster was reapplied for three months longer and fracture again attempted.

Since 1931, the author has treated about fifty cases of rachitic deformities of the lower extremities by such conservative measures at the Hospital for Joint Diseases*. The ages of the patients varied from eighteen months to three years. Some cases presented the active and others the quiescent stages of rickets. The usual preliminary period of immobilization in plaster was from four to six weeks, depending upon the age of the patient. There is a possibility that older children could be similarly treated by extending the period of plaster immobilization.

TREATMENT

The usual method of procedure is as follows:

Preliminary Decalcification

Roentgenograms and photographs are taken. In bilateral deformities of the lower extremities, a double plaster spica is applied from waist to toes. The patient is kept in bed. All antirachitic measures are suspended. After four weeks, another roentgenogram is taken and compared with the original to ascertain the degree of atrophy. (See Figures 1-A and 1-B.) The patient is then prepared for anaesthesia.

Correction of Deformities

After the casts have been removed, the skin is cleansed with benzine and alcohol. By means of gradual force, the limbs are slowly bent into a slightly overcorrected position. In milder cases, it is possible to straighten the limbs without fracturing the bones (Figs. 2-A and 2-B). In severer cases, greenstick fractures are produced (Figs. 3-A to 3-F inclusive). Excessive force is contra-indicated, and complete transverse fractures with displacement of fragments should be avoided. In multiple deformities,

* The author desires to acknowledge his indebtedness to Dr. A. L. Levy, Dr. B. Greenberg, and Dr. H. H. Green for their kind assistance and cooperation.

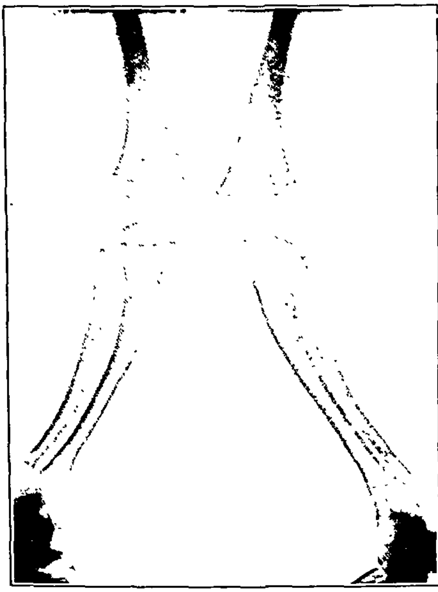

FIG. 1-A

Roentgenograms taken prior to onset of treatment. Note bone density.

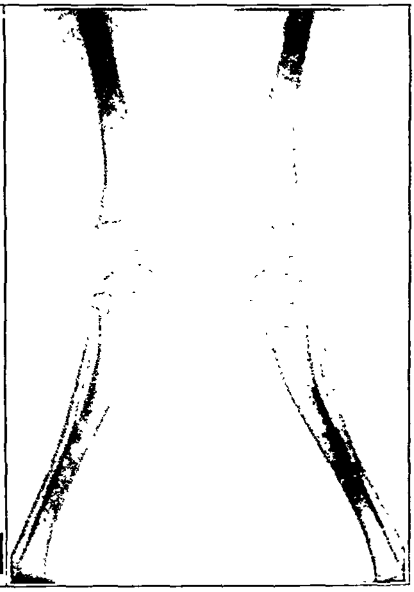

FIG. 1-B

Extent of decalcification five weeks after immobilization in plaster casts.

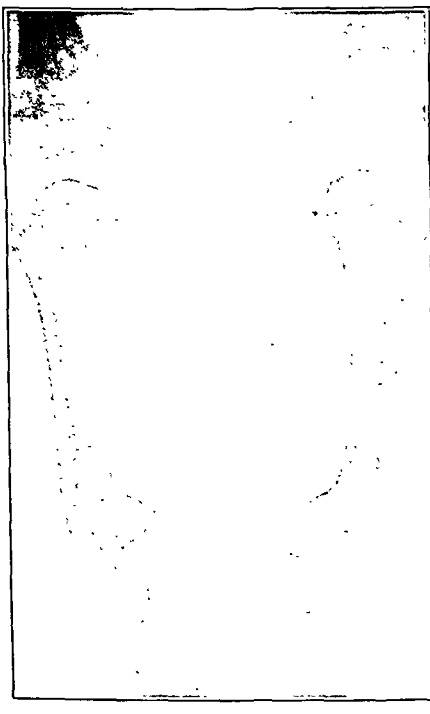

FIG. 2-A

Bowing deformities in lower third of the tibiae and the fibulae.

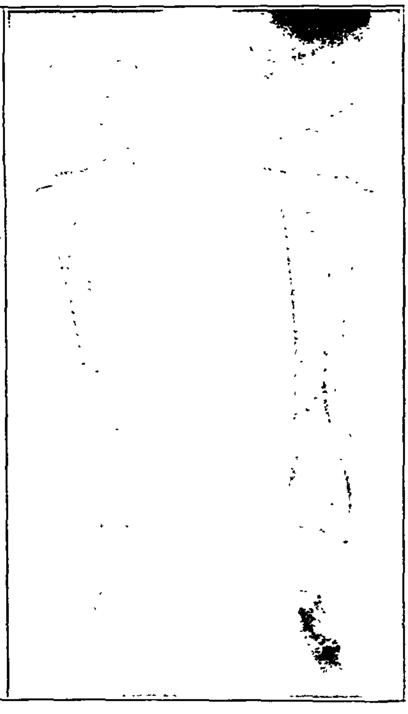

FIG. 2-B

Same case as shown in Fig. 2-A after correction by bending.

both tibiae, both fibulae, and both femora can be corrected at one sitting. In attempting manual correction, it is advisable to restore the normal relationship of the affected bones, special attention being directed toward paralleling the lower femoral and upper and lower tibial articulations, as suggested by Milch (Fig. 3-F). Extreme overcorrection of the deformities is unnecessary. Immediately after the correction, a double plaster spica is

FIG. 3-A

Bow legs before treatment (1931).

FIG. 3-B

Same as Fig. 3-A, after correction (1931).

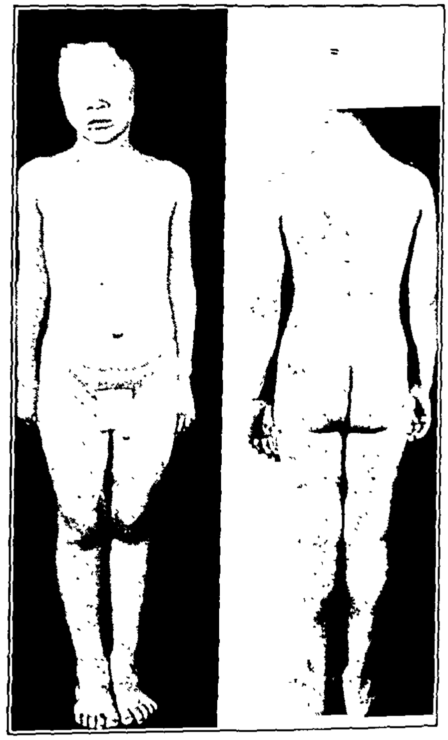

FIG. 3-C

Same case as Figs. 3-A and 3-B, three and one-half years later (1934).

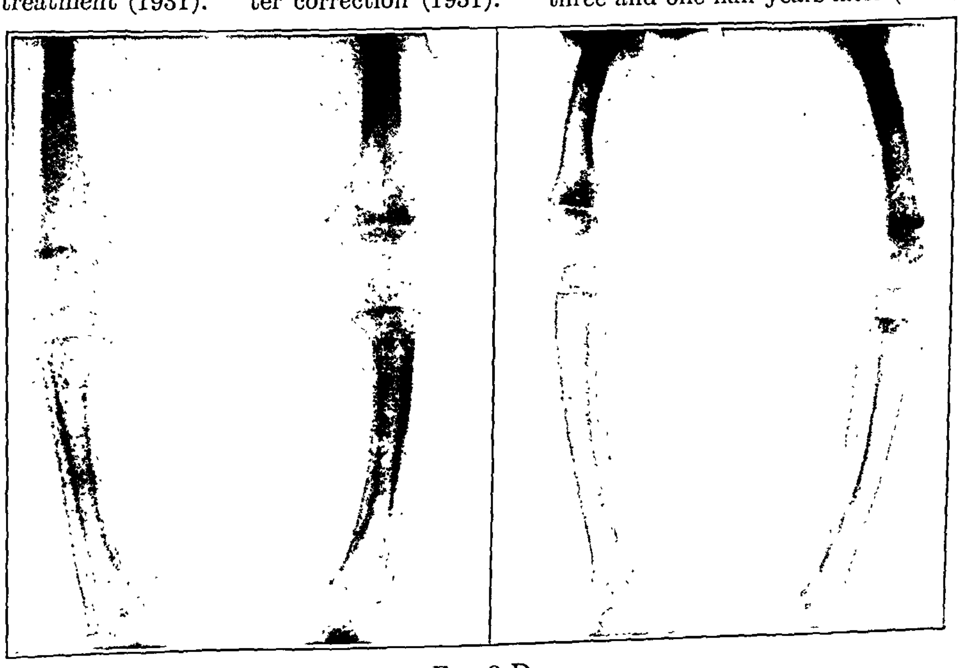

FIG. 3-D

X-rays corresponding to Fig. 3-A. Anterior and lateral views (1931).

Fig. 3-E

X-rays corresponding to Fig. 3-B, showing condition after correction by bending and greenstick fractures and the application of plaster casts (1931).

Fig. 3-F

X-rays corresponding to Fig. 3-C. Anterior and lateral views (1934).

applied and, when the plaster is thoroughly dried, roentgenograms are again taken to determine the extent of improvement. Should further correction be required, the plaster cast may be wedged.

Subsequent Recalcification

A few days after the redressement, general antirachitic measures are instituted. These consist of a high-vitamin diet, cod liver or haliver oil with viosterol, calcium phosphate, and exposure to ultraviolet rays. As soon as the roentgenograms show a sufficient recalcification, massage and exercises are begun, and gradually increased weight-bearing is encouraged.

Subsequent routine examinations are advisable over a prolonged period to determine the permanency of the correction and to detect recurrences at the earliest possible date.

FIG. 4-A
Showing knock knees before treatment.

END RESULTS

The end results of the above treatment have been most gratifying. No major complications have been encountered. The hospitalization period is very short, rarely exceeding ten days. The preliminary and subsequent treatments can be given in the Out-Patient Department. The fact that no open operation is necessary, appeals strongly to the parents. Furthermore, the occasional complications following open operations—such as displacements due to muscle pull, malunion, infection, osteomyelitis, delayed union, and non-union—are entirely obviated.

FIG. 4-B
Same as Fig. 4-A, immediately after removal of plaster casts. Showing correction of knock-knee deformities.

Nor can there be any comparison with the tedious and painful corrective-brace treatments and their uncertain results. But by far the greatest advantage of the conservative treatment lies in the fact that the deformities are attacked early, thereby avoiding the complicated distortions so often seen in later childhood, which necessitate such difficult procedures as are recommended in the literature by Sorrel, Löffler, Springer, Kirschner, etc., and which are striking evidence of the ineffectiveness of the simpler osteotomies in these advanced cases.

Under the caption of "Joint Hypotonia", the author in 1916 described an entity characterized by laxity of joint ligaments throughout the body, resulting in exaggerated joint motion and postural deformities, among which genu valgum was of frequent occurrence. These cases are not necessarily rachitic in origin. Attention is drawn to this group because of the frequent recurrence of deformity following open osteotomy. The treatment is preferably conservative. The tendency is for these patients to improve ultimately, providing the excessive joint motions are restricted by braces or plaster casts.

CONCLUSIONS

1. The author believes that rachitic deformities should be attacked at the earliest possible date, in order to prevent the development of subsequent complicated distortions of the limbs.
2. The conservative method described adequately corrects these early malformations.
3. Ample time has elapsed and a sufficient number of patients have been treated to warrant the assumption that the results obtained are of a permanent nature.

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CALCIFICATION IN THE SUPRASPINATUS TENDON

BY E. N. WARDLE, F.R.C.S., LIVERPOOL, ENGLAND

Thirty-seven cases of calcification in the supraspinatus tendon have to date been recorded in the literature. The limited number of such cases warrants the report of the following case which also contains one unusual feature.

A woman, aged thirty-five, was seen by the author on January 26, 1934. She had had occasional pain in the right shoulder for three years. One week previously she had stumbled while going downstairs and had wrenched her shoulder in the effort to save herself from falling. The pain had then become excruciating. She stated that, previous to this, pain had prevented her even from playing the piano.

On examination, the patient was found to hold the arm rigidly to the side; there was intense muscle spasm on any attempt at passive movement and she would undertake no active movement. Tenderness was present all around the shoulder. An x-ray (Fig. 1) at this time showed a diffuse and somewhat vague shadow above the head of the humerus under the acromion process; the appearance was as if the shoulder joint were partially subluxated, the center of the head of the humerus being on a level with the lower border of the glenoid fossa.

At operation, February 2, 1934, the anterior approach to the shoulder joint was used and the anterior edge of the deltoid muscle retracted. The insertion of the supraspinatus

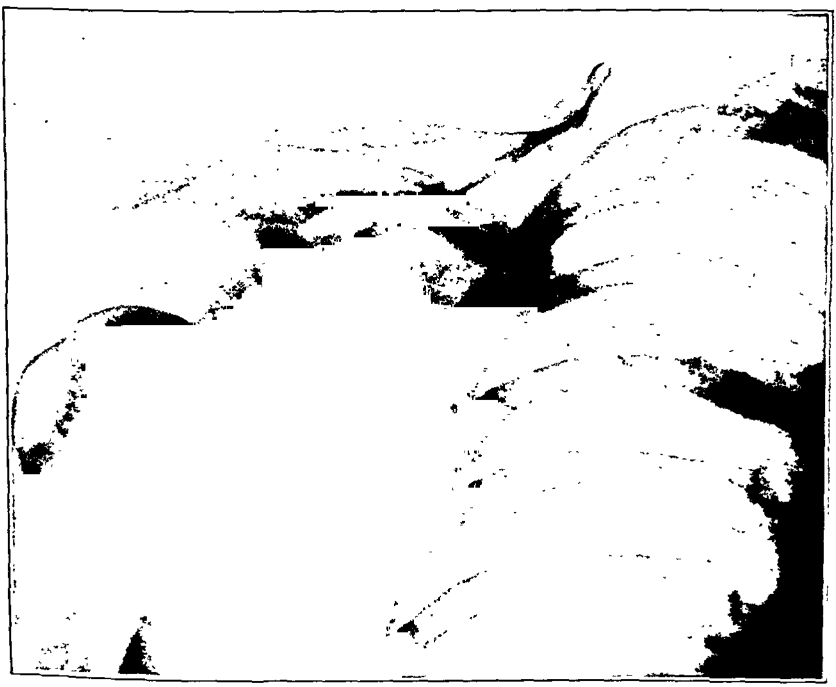

FIG. 1

X-ray of the right shoulder before operation, showing the shadow above the head of the humerus and the partial subluxation of the joint.

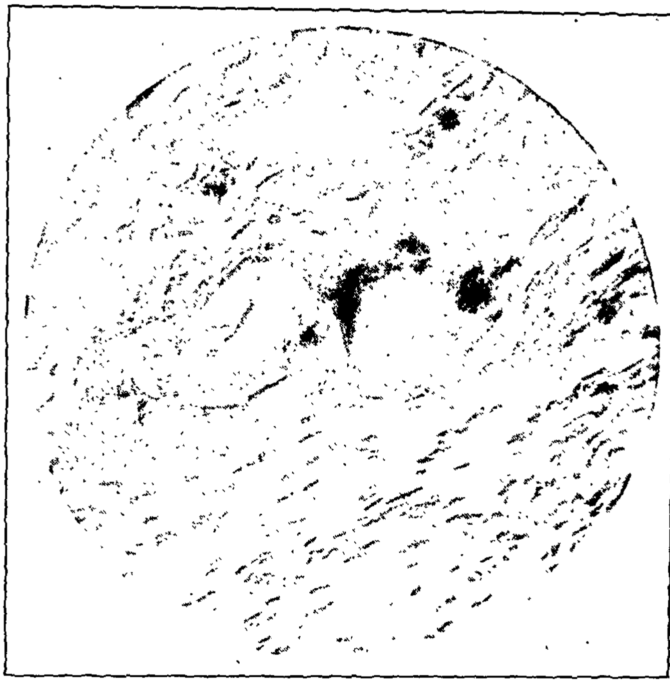

FIG. 2

Photomicrograph (×400), showing the deposit of amorphous calcium in fibrous tissue.

tendon was exposed and it could be seen that the center of this tendon was occupied by a yellow granular mass which was definitely solid. There was no tear of the supraspinatus tendon. The yellow material was removed with ease and, after the tendon was bound together with sutures, the wound was closed.

A section of the material was obtained (Fig. 2) and showed fibrous tissue containing masses of amorphous calcium. There were no facilities for a detailed chemical analysis, but the author was able to ascertain that the material consisted largely of calcium carbonate and phosphate.

Figure 3 shows the condition after operation.

On March 19, 1934, the pain was completely relieved. The patient was making good use of the shoulder and had a full range of abduction and external rotation.

The unusual feature of this case was the appearance of subluxation at the shoulder joint. On looking through the literature, the author

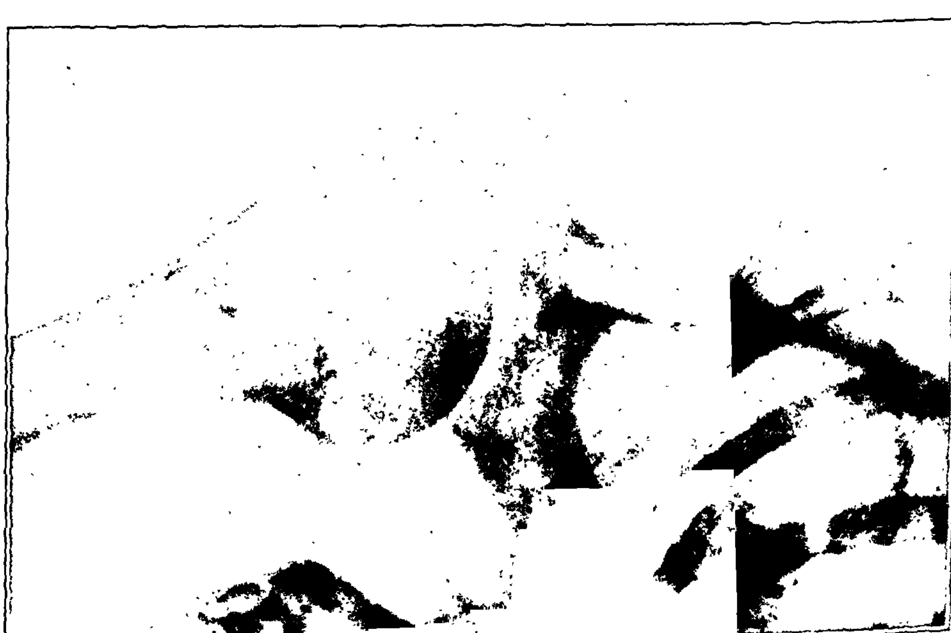

FIG. 3

X-ray of the shoulder after operation, showing the joint restored to its normal position.

found one x-ray in Elmslie's series (his Case 2) in which there was a similar appearance, but no comment was offered.

In other respects the case belongs to the subacute class with exacerbation. The limited arc of pain commonly described in these conditions was not present; the joint simulated an acute inflammation in its physical signs.

It seems to the writer that the usual anterior approach to the shoulder affords better facilities for dealing with this condition than the limited incision through the deltoid muscle which has been described in the literature.

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SPONTANEOUS SHELF FORMATION IN UNUNITED FRACTURE OF THE NECK OF THE FEMUR

BY SETH SELIG, M.D., F.A.C.S., NEW YORK, N. Y.

Various types of shelf operations have been widely used to stabilize dislocated hips, both congenital and acquired. This procedure has been used less often to stabilize hips which are painful because of an unreduced fracture of the neck of the femur. In the following case, a shelf was formed spontaneously to stabilize an ununited fracture of the neck of the femur. No operation has ever been performed in this case, in spite of the x-ray appearance, and for years the patient did not know that he had a fracture of the left hip.

I. H., a male, aged seventy-five, has had difficulty in walking for over twenty years. This difficulty came on gradually and was accompanied by loss of power in both lower extremities. There were also bladder disturbances which finally necessitated catheterization; this has been continued by the patient through the years. The diagnosis of the

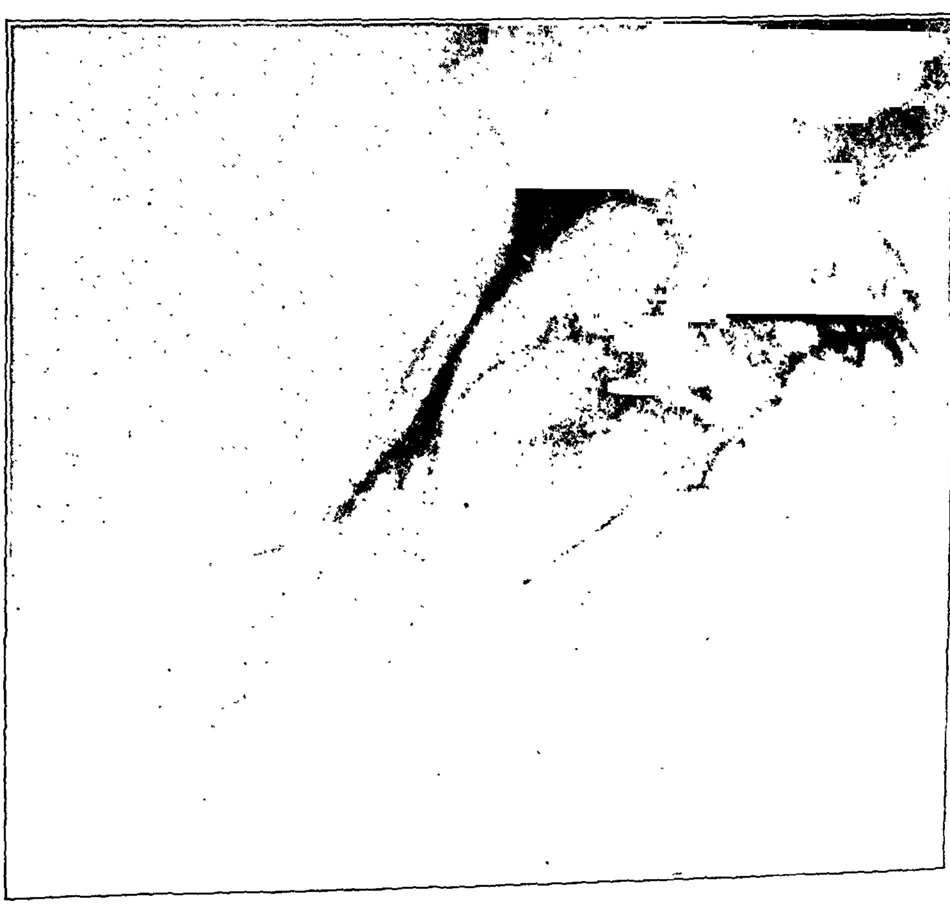

FIG. 1

Roentgenogram, seventeen years after fracture of the neck of the femur, shows an adequate, stable shelf produced spontaneously.

neurological disturbance is a myelitis on a luetic basis. The blood Wassermann test at present is negative.

Seventeen years ago, while walking down stairs, the patient fell and injured the left knee joint. The hip also was painful at the time, but no x-rays were taken of the hip joint. He was put to bed and it was eight weeks before he was able to walk again, and then he could not walk without the aid of crutches. Since that time, crutches or canes have been used. The patient complained of vague pains in the region of the left hip joint when he first began to walk, but recently the only disability of the left hip has been due to a shortening of about two inches. This was noticed by the patient and the patient's physicians, and the shoe was elevated to compensate for the difference in length. Because of the fact that the neurological disturbance was the more definite disability, no further attention was paid to the left hip.

The patient was first seen by the author on October 29, 1934. In addition to the neurological changes, there was noted a shortening of two inches of the left lower extremity. Motion, however, was free in all directions except at the extremes of abduction, internal rotation, and flexion. No telescoping of the hip could be obtained and the Trendelenburg test was difficult to evaluate because of the overshadowing nerve condition which interfered with the patient's ability to balance himself on either extremity.

A roentgenogram (Fig. 1) revealed an ununited intracapsular fracture of the neck of the left femur with considerable atrophy of the fragments. The remarkable feature of the case, however, was a solid, stable shelf that projected from the side of the ilium and afforded a firm, articulating surface for the upper end of the femoral shaft. The inner aspect of the shelf, at the point of its junction with the ilium, was about one and one-half inches thick and tapered to five-eighths of an inch at its external aspect.

The explanation of the unusual bone formation in this case is probably a calcareous deposit in the gluteus minimus muscle, with subsequent bone formation. The osteoma had been molded and shaped by the stress and strain of use to the shape seen in the roentgenogram. The fact that the patient has been luetic is, the author believes, merely coincidental. In a case of ununited fracture of the neck of the femur an even larger osteoma in the substance of the psoas iliacus muscle has been reported by P. Funck-Brentano[1].

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LOCAL ANAESTHESIA IN KNEE ARTHROTOMIES

BY CHARLES ROMBOLD, M.D., F.A.C.S., WICHITA, KANSAS

The use of local anaesthesia in knee arthrotomies has been previously described. However the procedure has not been sufficiently popularized to result in its wide-spread employment. Novocain anaesthesia in knee arthrotomies is devoid of danger; it shortens the period of convalescence; and it so simplifies the operation that many patients who would otherwise refuse it are willing to avail themselves of this surgery. Knee arthrotomies performed under local anaesthesia have been so consistently successful in the writer's practice that he now employs this procedure as a routine technique.

During the past eighteen months, the writer has employed novocain locally in thirty-nine cases of knee surgery, including removal of the menisci, removal of joint mice, débridement of the patella, removal of the sequestra of osteochondritis dissecans both before and after their detachment, resection of the infrapatellar fat pad, and biopsy. Not once during the course of these procedures was it necessary to resort to a general anaesthetic. With very few exceptions, the patients volunteered the statement that they would prefer the local anaesthetic to a general anaesthetic.

The contra-indications to the use of local anaesthetic in knee arthrotomies are:

1. Hypersensitive, uncooperative patients and children.

2. Acute inflammation of the synovia. The infiltration of the novocain in the various tissue planes, rather than a nerve block, produces the anaesthesia in knee arthrotomies. Novocain infiltrated into any inflammatory area is relatively ineffective in relieving pain. The inflammation of the synovia, whether it be a result of recent trauma or of infection, prevents adequate anaesthesia of this plane. Thus, following recent injury of the knee, or in the presence of acute infection, local anaesthesia is relatively ineffective.

3. Very extensive exploratory procedures. Because of the frequent necessity of very wide, forceful retraction and the occasional necessity of changing the normal relationships of the bones, local anaesthesia in certain exploratory procedures should not be attempted. Anaesthesia which does not extend beyond the infiltrated area does not allow a very wide latitude of manipulation.

The technique followed is described in detail by Labat [1]. The skin and subcutaneous tissues are thoroughly infiltrated with 1 per cent. novocain along the line of the intended incision. The adjacent areas are also infiltrated with the anaesthetic and about twenty to thirty cubic centimeters are injected directly into the joint space. The skin incision is made and carried through the subcutaneous tissue, and the skin towels

are then applied. The capsule of the joint is then infiltrated, the incision is deepened into the joint space, and the procedure is completed.

Hemostasis is obtained by the addition of adrenalin to the novocain solution. Due to the clamping of the larger vessels and the addition of the adrenalin to the novocain, the fields are sufficiently bloodless to make a tourniquet unnecessary.

Stabbing at the synovia with a sponge causes pain. Sponging within the knee should be gentle, although considerable pressure may be applied if the sponge is carefully placed and the pressure increased slowly. Also retraction should not be jerky, but may be quite forceful if the retractors are carefully introduced and the pressure gently increased.

If the infrapatellar fat pad is to be removed, infiltration with the novocain solution is essential. If an area of synovia other than that infiltrated for the incision is to be removed, a further injection of novocain is necessary. Occasionally, when the menisci are to be removed, it will be found necessary to inject the capsule of the joint at their insertion.

With the careful observation of the precautions of gentle sponging, firm, steady retraction, and careful infiltration of the entire operative field, knee arthrotomies may be successfully performed under novocain anaesthesia. The routine use of local anaesthesia in minor surgery of the knee joint has proved so uniformly successful that it is to be recommended as a valuable technique in these procedures.

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A CHAIR FOR BILATERAL ANKYLOSIS OF THE HIP JOINT

BY JOHN G. KUHNS, M.D., BOSTON, MASSACHUSETTS

From the Robert Breck Brigham Hospital

Ankylosis of the hip joint interferes seriously with both sitting and walking. If both hip joints are stiff, a not uncommon occurrence in rheumatoid arthritis of the spinal type, standing may be possible, but sitting is wholly impossible. Attempts at reclining by leaning backward against any support result in the pelvis sliding forward, so that the weight may come upon the ischial tuberosities and the gluteal masses, the usual supports in sitting. It has been the practice of physicians in cases of spinal arthritis, where ankylosis of the hip joint seemed inevitable, to permit such ankylosis to occur in almost complete extension and in slight abduction. In this position lying and standing can be carried out with relative comfort, and walking to some extent is still possible. Ankylosed hips in the spinal type of rheumatoid arthritis often do not respond favorably to arthroplastic procedures.

The patient shown in Figure 1 had four separate attempts at arthro-

FIG. 1

FIG. 2

plasty by various competent surgeons without success. This patient is earning his living as a draftsman. In an attempt to keep him continuously at work and at the same time to give him relative comfort, a special chair was devised.

This chair has since been modified to suit the needs of the individual patient. It consists of four wooden uprights, one by two inches. The height of these uprights varies and is determined by the distance from the iliac crest of the patient to the floor. The inside anteroposterior and lateral diameters are usually twenty inches. The uprights are connected at top and bottom by wooden strips, one by two inches. Diagonal struts may be needed in very heavy individuals. The seat consists of a canvas sling padded with felt. This seat (Fig. 2) has lateral and posterior supports, with canvas straps which come between the legs and fasten anteriorly; these prevent the patient from slipping forward. Most of the weight in this sling is borne by the gluteal masses and ischial tuberosities. The various types of bicycle seats were used in this hospital for these patients, but were never satisfactory since the weight in sitting came almost entirely upon the perineal region.

A folding model of this chair with leather rest and uprights of aluminum tubing is carried by one patient to and from work.

The chair is presented as a useful piece of apparatus particularly for those in whom the arthritis is not wholly quiescent, or for whom arthroplasty is not feasible. The total cost is about five dollars.

THE CRÊPE-PAPER BANDAGE VERSUS THE SHEET-WADDING ROLL

BY ALFRED J. BUKA, M.D., PITTSBURGH, PENNSYLVANIA

Because of the many helpful features offered by the crêpe-paper bandage, in comparison with the sheet-wadding roll, as a protective covering and encircling cushion between the plaster cast and the body, its use is strongly advocated and the author wishes to report his experience with this type of bandage. The substitution of crêpe paper for sheet-wadding was suggested by the need of a flexible, resilient, soft material which, when it encircled a part, would grip firmly, evenly, and easily, yet compensate for a certain amount of frequent swelling to retained parts. When constant and even pressure of a cast against a part must be reckoned with, the sheet-wadding roll does not compare in comfort with the crêpe-paper bandage. This type of bandage may be made in any of the ordinary widths, the favored length being sixty feet.

The author began using this product extensively in industrial surgery, in 1915. Crêpe paper was then being offered as a convenient and economical substitute for gauze. As such, it proved to be unsatisfactory. It did not present the usual properties of gauze necessary for use in the ordinary industrial accident in which there is injury to the bone. But, in a bone injury when a cast was required, the cast was applied over an encircling crêpe-paper bandage. It was found that this material not only possessed all of the advantages of the sheet-wadding roll, but its application was easier and better. Therefore, in those orthopaedic conditions requiring plaster casts, the author substituted the crêpe-paper bandage for the sheet-wadding roll, without mishap or regret, until it "went off the market". Wadding is known to give or yield unevenly where swelling occurs, thus encouraging the development of other complications. Since the crêpe-paper bandage possessed flexibility, resiliency, and softness, it was felt that its use would combat such complications.

In fields of operation requiring a cast, the crêpe-paper bandage appeared to control hemorrhage better than sheet-wadding. The very looseness of sheet-wadding and its failure to hold firmly and evenly encourages undue seepage. Wadding becomes annoyingly soppy and heavy when bleeding occurs, which often interferes with the proper setting of the cast.

It is the custom to place stockinet over a part before padding with a crêpe-paper bandage. The stockinet should extend liberally beyond the edges of the paper bandage and the latter should extend slightly beyond the area to which the cast is to be applied. After the application of a cast, the ends of stockinet and crêpe paper are folded over the plaster windings. The edges of the cast are then covered with plaster cream or a narrow

plaster bandage. Sheet-wadding is of course still considered valuable for padding over bony ridges or other prominences.

While with Prof. Fritz Lange at the Krüppel Heim, Munich, in 1928, the author derived considerable satisfaction in seeing that this splendid training school was also using the crêpe-paper bandage for padding between body and plaster. In all cases at this institution in which immobilization in plaster was necessary, crêpe paper was the material of choice for protective wrapping.

CONCLUSIONS

The advantages of the crêpe-paper bandage over the sheet-wadding roll are:

1. There is greater possibility for the application of a form-fitting cast, with correct contour of the part, especially after operative procedures have been realized.

2. The completed cast is much less clumsy, is lighter in weight, and permits freer movement of the part.

3. The crêpe-paper bandage exerts an even pressure on all sides; therefore there is less danger from swelling, and better control of hemorrhage when an open wound must be considered.

4. The cast is easier to remove. When it is necessary to split the cast, the crêpe-paper bandage holds the incorporated parts more firmly.

5. This material allows for swelling; yet, after diminution of the swelling, the windings for padding promptly recoil to the original tension and pressure.

6. Crêpe paper is no more expensive than sheet-wadding.

It has been difficult lately to secure the crêpe-paper bandage. However, now that its value has been established in the field of orthopaedic surgery, it is believed that arrangements will soon be completed so that it will again be offered on the market. When the crêpe-paper bandage becomes available, it is hoped that it will gain merited favor over the sheet-wadding roll.

SPINAL PELVIC COMPRESSION BRACE

BY B. KOVEN, M.D., AND M. T. KOVEN, M.D., BROOKLYN, NEW YORK

The principle on which this apparatus is based is one of firm lateral compression against the ilia, which results in a coaptation of the pelvic joints.

The pelvic plates are placed so that firm lateral compression of the ilia is obtained and the forces are distributed equally to the anterior and posterior parts of the pelvic girdle. The necessity for such a mechanism in conditions of pelvic instability is well recognized. It is chiefly indicated in the treatment of pelvic fractures, separation of the symphysis pubis, and instability of the sacro-iliac joint, either traumatic or post-partum.

The brace is of light weight and so molded as not to appear bulky. If accurate measurements for the pelvic plates are made, there is no pressure on the anterior portion of the ilia or on the lower abdomen.

Construction:

Measurements for the pelvic plates are made by molding lead tapes over the crests. The heights of the upright bars are measured to a level between the eighth and tenth ribs. The upper cross bar is measured as in a Knight spinal brace.

The pelvic plates are hammered out of duralumin and fitted to conform to the lateral aspects of the ilia. The upper margin of each plate fits just below the crest of the ilium; the lower margin extends to the upper surface of the greater trochanter; the anterior margin is curved in a line just behind the anterior superior spine; the posterior margin curves to the back to a line extending down from the posterior superior spine. The

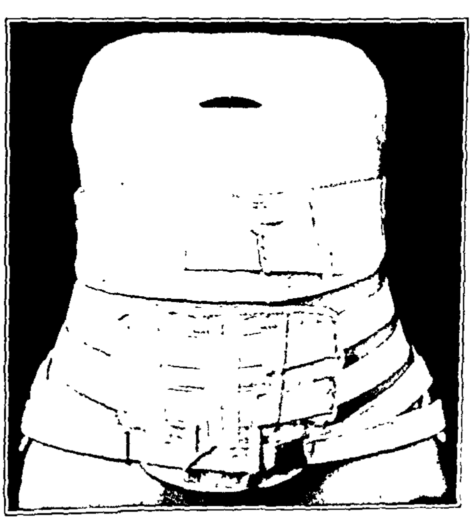


Fig. 1

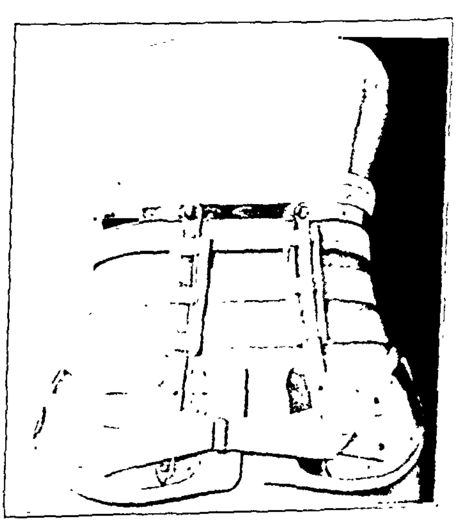


Fig. 2

upper cross bar is one-half inch wide, extending across the lower dorsal region to the axillary line. The uprights are attached to this cross bar by free-moving rivet joints; they are attached to the pelvic plates by fixed rivets. The compression is made by one-inch heavy elastic webbing. The straps are riveted to the pelvic plates and the pull is equally distributed to the front and back by making each strap in two sections which buckle in the front and back. A loose ptosis apron is used with webbing straps which encircle the upright bars.

An ordinary abdominal girdle or corset can be worn over the brace making the apparatus inconspicuous.

ANKLE-JOINT STABILIZATION WITH MOTION

BY P. M. GIRARD, M.D., DALLAS, TEXAS

The method of stabilization to be described is useful in the treatment of flail feet. The procedure is combined with a triple arthrodesis and offers a very stable ankle joint, with a varying degree of motion. This is a preliminary report, as the operation has been done in only twenty-four cases, and was first employed thirteen months ago (December 1933).

The arthrodesis of the ankle joint which is now being done rather extensively affords stability, but does not give as good function as is desired, due to lack of motion. The indications for the procedure used by the author are a complete dangle foot or flail foot, or one which is nearly

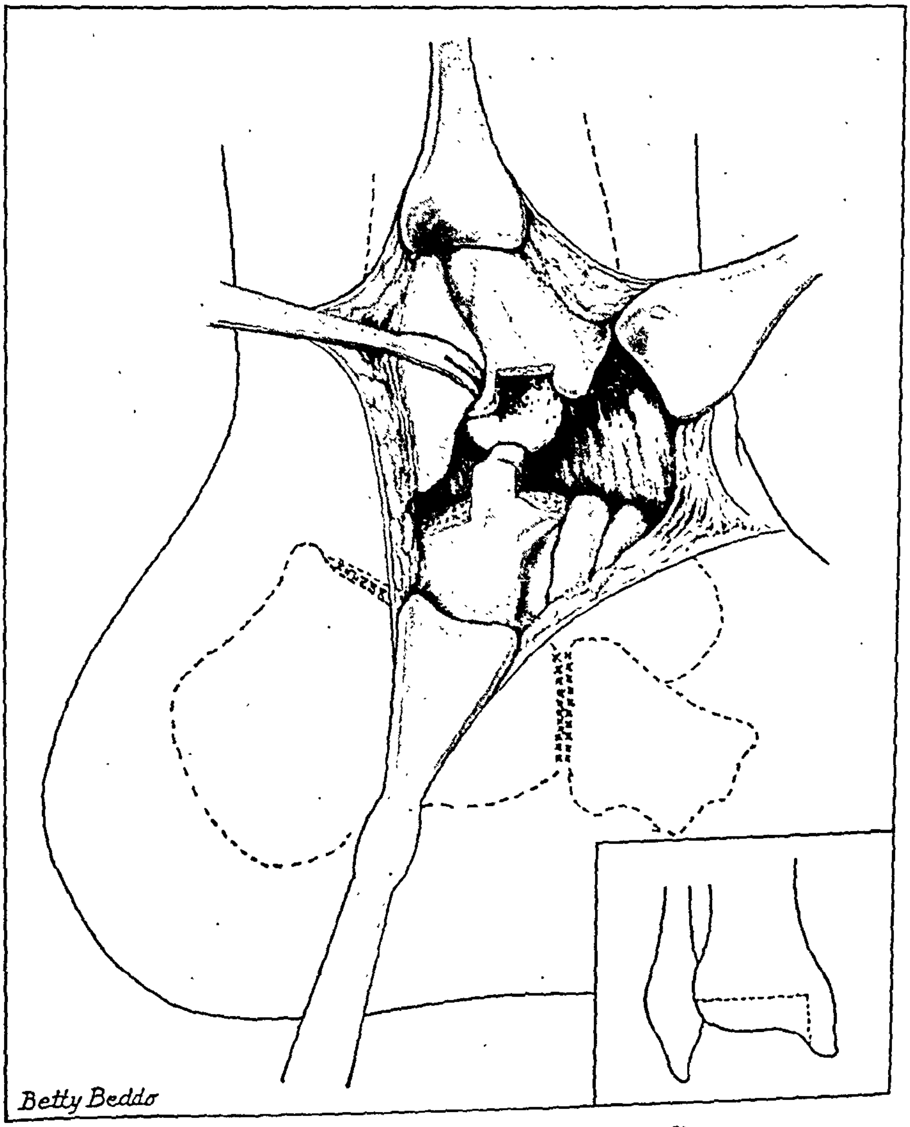


FIG. 1-A FIG. 1-B

Drawing showing construction of the mortice in the ankle joint.

so. The results have been very gratifying, the degree of motion obtained in the twenty-four cases operated upon varying from 10 to 20 degrees. In only one case did the ankle joint fuse, and this fusion was not considered a serious development, as arthrodesis is so frequently recommended and performed in such cases. The degree of motion can be predicted and varied as desired, according to the relative depth of the component parts of the mortice.

TECHNIQUE

The same type of incision is used as for arthrodesis of the ankle joint,—beginning over the astragaloscaphoid joint, crossing obliquely, and turning upward just in front of the lateral malleolus.

A triple arthrodesis is next done, fusing the astragaloscaphoid, the cuboid, and the subastragalar joints. In fusing the astragaloscaphoid joint, the head and the neck of the astragalus are removed to permit displacement forward of the astragalus. The neck of the astragalus is shortened to allow backward displacement of the foot before the head is replaced. As in any stabilization of the foot, this is considered very important.

The mortice in the ankle joint is next done. The ligaments attaching the astragalus to the lateral malleolus are severed and the astragalus dislocated forward. A groove, about three-sixteenths of an inch deep and one-quarter of an inch wide, is cut transversely across the front portion of the articular surface of the tibia, and continued into the medial malleolus (Fig. 1-B). This is to permit the morticed portion of the astragalus to rock forward and backward. It is usually not necessary to groove the lateral malleolus in this manner.

The astragalus is next restored to its normal position and the foot placed in the desired degree of equinus (depending on the shortening in the leg). Markings are now made on the side of the astragalus, indicating the site and width of the projection which is to fit the mortice in the tibia

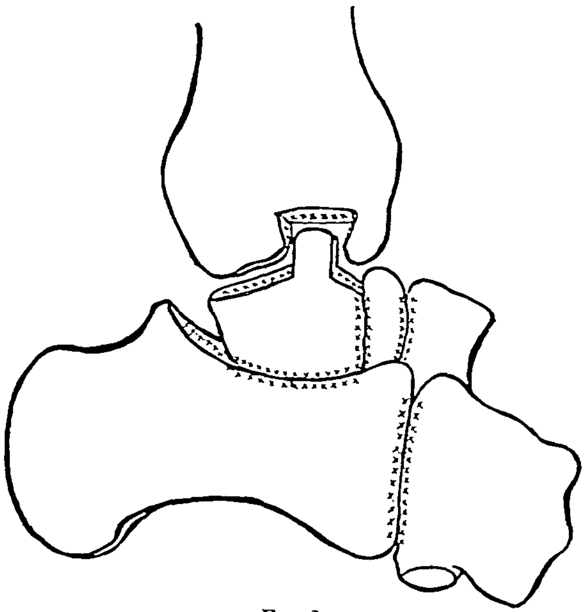


FIG. 2

Drawing illustrating the mortice in the ankle joint, shortening of the neck of the astragalus, fusion of the astragaloscaphoid and cuboid joints, and backward displacement of the foot.

(Fig. 1-A). It should be noted that, as these dangle legs are always shorter, the most satisfactory position of the foot is in some equinus. The projection on the astragalus, therefore, falls on the middle or posterior end of the astragalus. This is also the reason for placing the groove in the tibia forward. After the astragalus has been marked with a sharp osteotome, the anterior and posterior portions are cut away, leaving the projection to fit the mortice.

Obviously the relative width and height of the projection of the astragalus, as compared to the depth and width of the groove in the tibia, can be varied, thus changing the degree of motion and stability. Also, the amount of the astragalus removed (front and back) governs the points at which the foot will block in dorsiflexion and plan-

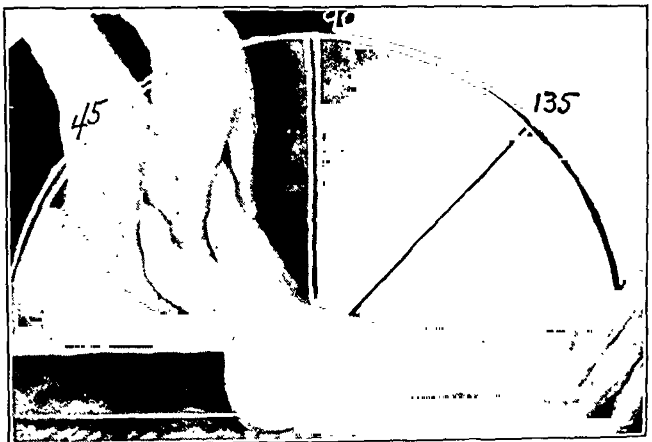
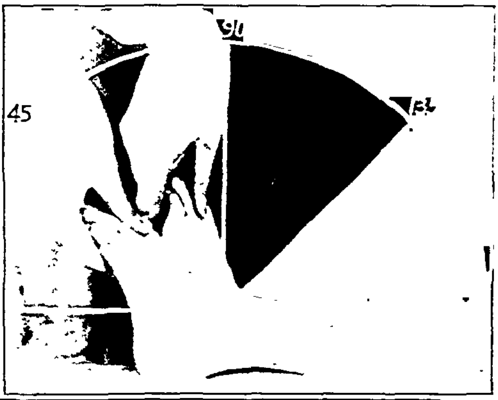


Fig. 3

M. J. G., aged eight years. Five months after operation. Fifteen degrees' painless motion in the ankle joint. The foot is set in equinus for one and three-quarters inches of shortening of the leg.

tar flexion. The groove should be about one-eighth of an inch wider than the astragalar portion of the mortice.

The astragalus has now been replaced and the mortice fitted (Fig. 2). Next it is necessary to check the degree of equinus and the amount of motion in the ankle joint. If the foot is not in enough equinus, additional bone is removed from the posterior part of the astragalus; if too much motion is present, the groove in the tibia is deepened. Obviously, with these variable factors under control, the exact degree of motion desirable with the relative stability, as well as the correct position of the foot, may be obtained.



A variation of the procedure has already been carried out by an associate, Dr. W. B. Carrell. The projection of the astragalus, which fits into the mortice of the tibia, is made from a section of the head of the astragalus and is

FIG. 4

D. M., aged eight years. Seven months after operation. Twenty degrees' painless motion in the ankle joint. The foot is set for no shortening in the leg.

driven firmly into the astragalus (Fig. 5). The advantage of this variation is that no shortening is produced by the operation. However, the stability in the ankle joint has not been quite as satisfactory as in the method here reported.

It has been considered that this procedure, with the mortice reversed, would be useful in cases of extreme trauma—such as extensive comminuted fracture in the ankle joint—instead of an ankle fusion, as is frequently done. In making the projection in the tibial surface, all of the roughened surfaces would be removed from the tibia and a painless joint with 10 degrees' motion should result. This reversed mortice has been done experimentally only.

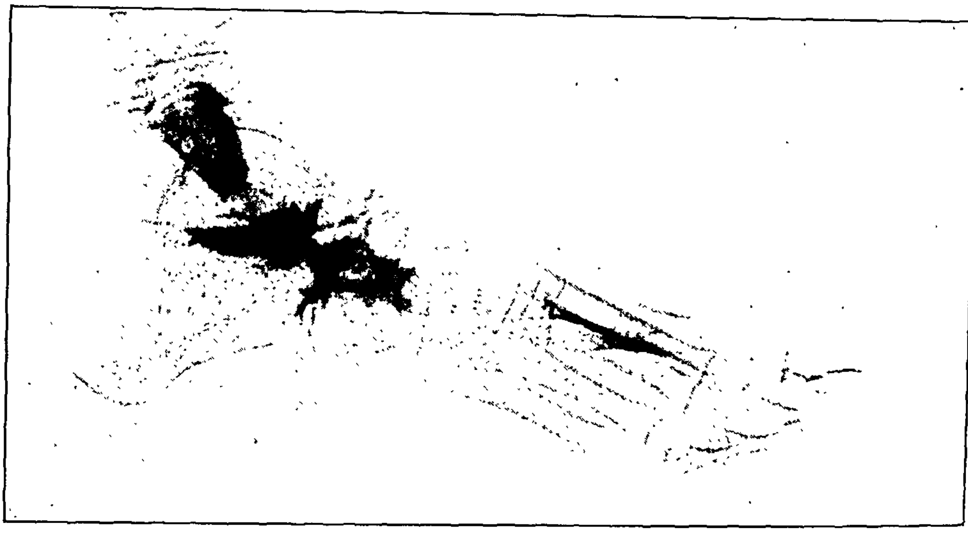


Fig. 5

Roentgenogram illustrating variation in the technique. The mortice in the tibia was similar to that in the previous cases, but projection on the astragalus was made by driving a wedge-shaped piece of the head into the astragalus.

The plaster-fixation routine is similar to that employed after other operations for foot stabilization,—namely, a cast for six weeks, change of cast and application of a walking stirrup for another six weeks, and an ankle brace for three months.

COMMENT

The final evaluation of this procedure cannot yet be established, as sufficient time has not elapsed. The youngest child operated upon was eight years old. While the mortice in the tibia is in the epiphyseal end, it is not deep enough to reach the epiphyseal line and should not affect the growth. No alteration in growth has been noted as yet. One of the twenty-four feet thus stabilized is still slightly painful five months after the operation. All the others which are out of plaster are painless. In one case the morticed astragalus dislocated forward and instability has occurred. All of the other feet are stable.

This type of ankle-joint stabilization, combined with the orthodox triple arthrodesis, has so far given promise of excellent results in dangle feet.

GEORGE ROBERT ELLIOTT

Dr. George Robert Elliott died on April 27, 1935. He left a host of admirers in New York City, where he practised medicine for about fifty years. His simplicity, kindness, unselfishness, and sympathetic understanding made him an ideal physician.

He was born in Sennett, a suburb of Auburn, New York, and was graduated from the Auburn High School in 1873. He attended Cornell University and received his degree in medicine from the College of Physicians and Surgeons in 1881.

His first interest was in pathology and, after considerable post-graduate work, he was appointed pathologist at the New York Hospital, the first paid pathologist in the City of New York. He retained his interest in pathology throughout his life so that later, when he found his true field in orthopaedic surgery, his dissection of joints from patients served to substantiate in some cases and disprove in others the statements of Nichols and Richardson.

It was in connection with his work as pathologist that his opinion was sought in the case of General Grant.

He became interested in orthopaedic surgery early in his professional career and did pioneer work at the New York Post-Graduate Hospital where, together with Roberts and Phelps, he conceived the idea of recording the gaits of patients by the use of ten cameras properly spaced. He studied abroad in 1896 and became interested in the closed reduction of congenital dislocation of the hip. He was the first one in the United States to demonstrate this method.

The thesis presented before his admission to the American Orthopaedic Association was on "Pathological Studies in Chronic Arthritis". Many prominent physicians at that time remarked that his paper had made the Meeting "worth while".

His hobbies were reading, music, and sculpture. He read extensively and deeply in biography and political philosophy. His violin-playing was better than that of an amateur. But his greatest success (outside of his profession) lay in sculpture; many of his efforts had real artistic merit. His writings were models of clearness and conciseness and many may be read now with interest and benefit.

He was a member of the County and State Medical Societies and of the American Orthopaedic Association, and a Fellow of the American Medical Association and the American College of Surgeons.

He taught by example more than by precept. He showed how far kindness and sympathy can go in the successful treatment of a patient.

WILLIAM JACKSON MERRILL

Dr. William Jackson Merrill was born in Maine on March 28, 1869. He died in Philadelphia, Pennsylvania, May 10, 1935. He is survived by a wife and two children.

He received his Bachelor's degree from Bowdoin College and his medical degree from the University of Pennsylvania. He served an internship in the University Hospital, was Chief Resident Physician in the Bryn Mawr Hospital, and then became the first Resident Surgeon in the newly organized Widener Memorial School for Crippled Children in Philadelphia. It was at the Widener School that he received his first training in orthopaedic surgery under Dr. DeForest Willard, whose interest and efforts were largely responsible for the building and the endowing of this unique and noble institution. Dr. Merrill did noteworthy work there in directing the physical equipment of the School and in organizing its manifold activities.

Later he studied abroad in Vienna, Berlin, Paris, and London, and on his return to Philadelphia he devoted himself exclusively to the practice of orthopaedic surgery. At the time of his death he was Orthopaedic Surgeon to the following hospitals and institutions: Children's, Misericordia, Fitzgerald's Mercy, St. Edmond's Home for Crippled

Children, and the Children's Seashore House in Atlantic City. He was Consulting Surgeon to the Jewish Hospital.

In 1917 he enlisted as Captain in the Army, and served in Camp Oglethorpe and in Camp Dix until his honorable discharge from the Service in 1919.

For the last twelve years of his life he spent three days of each month in conducting clinics for crippled children in Williamsport, Danville, and Lock Haven, with the support of the Rotary Clubs of these communities. Probably the best and the greatest work of his life was done there, but this work took a great toll of his strength and energy. He gave himself without stint and with little or no financial recompense to this service to crippled children, and there is today an amazing grief, as well as a beautiful memory, in the hearts of all his patients and his associates.

Dr. Merrill had great ability as a craftsman and had an instinctive mechanical gift. In the mechanical therapy of orthopaedic surgery he was preeminent. His great strength of hands and arms constituted a peculiar endowment for manipulative surgery.

His personality was delightful and he was most companionable. Courteous, generous, high-minded, incapable of a low or mean thought or act, he was one of Nature's gentlemen. His heart was soft and gentle. There was a sensitive and wistful part of his nature that felt beyond ordinary measure a kind or appreciative word. Always his work was the dominating interest in his life. He worked hard and played hard. He wore himself out and died at sixty-six, when his tremendous strength and vitality should have carried him to a good old age.

PHILIP WILLIAM NATHAN

Dr. Philip William Nathan died in New York City on April 20, 1935, after a brief illness. He is survived by his wife, Jennie Lewine Nathan, and four children.

Dr. Nathan was born in New York on September 24, 1872. He was graduated from New York University Medical School at the early age of twenty and continued his medical studies at the University of Berlin for a period of three years. In 1899 he became affiliated with the Hospital for the Ruptured and Crippled and the New York Polyclinic Hospital and later he was appointed orthopaedic surgeon to Mt. Sinai Hospital, Beth Israel Hospital, and Montefiore Hospital. The many duties that these appointments entailed made it necessary for him to resign from the staff of the Hospital for the Ruptured and Crippled.

Dr. Nathan was a Fellow of the New York Academy of Medicine, the American College of Surgeons, and an Honorary Fellow of the Irish College of Surgeons. In 1903 he was elected to membership in the American Orthopaedic Association, with which organization he was affiliated until the time of his death.

During the World War he served with distinction as a major in the United States Army.

Early in his career, Dr. Nathan became interested in the problems of arthritis, dealing particularly with the pathology and the mechanical aspects of this disease. His interests were diverse, however, and included significant contributions in other branches of orthopaedic surgery. Studies on bone transplantation, chondrodystrophia foetatis, poliomyelitis, lateral curvature, and rachitis were prominent among these. In 1932 he published an exhaustive and significant monograph on acute infection of the hip joint, which was of wide influence upon the treatment of this condition.

His interests were not narrow. He was a graduate of the Berlin Conservatory of Music and maintained his love for music throughout his life. He was an enthusiastic student and collector of books and etchings. His broad cultural and professional background augmented the kindness and depth of understanding with which he was naturally endowed. Patients and associates were devoted to him and, while his companionship and friendship were sought by many, they were available to few.

News Notes

On March 16, 1935, the *Editor* was elected an Honorary Member of the Leningrad Society of Orthopaedic Surgeons.

At the opening ceremonies of the new laboratory and X-Ray Department of the Hospital for the **Hospital for the Ruptured and Crippled** held in New York on April 17, the speaker was Dr. Robert B. Osgood of Boston. His address was on the subject of "Orthopaedic Surgery, Where From and Where To".

The Congress of the **Czechoslovakian and Yugoslavian Orthopaedic Society** is to be held in Brno on September 27 and 28. The principal subject for discussion will be Low Back Pain and the discussion will be lead by Professor Frejka of Brno, Docent Gradojevič of Belgrade, and Dr. Miroslav Jaroš of Prague. On the evening of the second day will be held the General Assembly of the Union for the Care of Crippled Children.

At a recent Executive Meeting of the **British Orthopaedic Association** the following were elected Associate Members:

John Bastow, F.R.C.S., 19, Queen Square, Bath.
C. J. O'Reilly, D.S.O., M.B., B.Ch., St. Kilda, Avoca Avenue, Black Rock, Co. Dublin.
K. Hampden Pridie, M.B., F.R.C.S., 40 Apsley Road, Clifton, Bristol.
J. R. Ratcliffe, M.B., Park Gate, Duffield Road, Derby.
D. N. Rocyn-Jones, M.B., M.R.C.S., L.R.C.P., Prince of Wales Hospital, Cardiff.
W. C. Somerville-Large, F.R.C.S.I., 16 Fitzwilliam Place, Dublin.
T. T. Stamm, F.R.C.S., 18 Leigham Avenue, S.W. 16.

The Forty-Ninth Annual Meeting of the American Orthopaedic Association was held in Philadelphia, June 5 to 8, under the presidency of Dr. DeForest P. Willard. One hundred and three members and one hundred invited guests were registered.

The morning of the first day was devoted to the clinical presentation by the Philadelphia members of cases illustrating important subjects. The morning of the second day was devoted to a symposium on arthritis. Dr. Willard delivered his Presidential Address at the opening of the afternoon session of that day, and the remainder of the Meeting, until Saturday noon, was given to the presentation of papers by members and guests. A particularly large number of valuable papers were read and discussed. The list of papers will be found on pages 517 and 518 of the April issue of *The Journal*.

The Annual Banquet was held on Thursday evening.

The President-Elect, Dr. Frederick J. Gaenslen of Milwaukee, Wisconsin, succeeds Dr. DeForest P. Willard as President for the year 1935–1936.

The following officers were elected for the ensuing year:

President-Elect: H. Winnett Orr, M.D., Lincoln, Nebraska.
Vice-President: Roland Hammond, M.D., Providence, Rhode Island.
Treasurer: John L. Porter, M.D., Evanston, Illinois.
Secretary: Ralph K. Ghormley, M.D., Rochester, Minnesota.
Member of Membership Committee: Robert Schrock, M.D., Omaha, Nebraska.
Member of Program Committee: Arthur Krida, M.D., New York, N.Y.

Delegates to the American College of Surgeons: John Dunlop, M.D., Pasadena, California; C. LeRoy Lowman, M.D., Los Angeles, California; Frank R. Ober, M.D., Boston, Massachusetts.

Delegates to The American Board of Orthopaedic Surgery: George E. Bennett, M.D., Baltimore, Maryland; Robert B. Osgood, M.D., Boston, Massachusetts.

At the Executive Session held on June 8 the following seven orthopaedic surgeons were elected to membership:

William A. Boyd, M.D., Columbia, South Carolina.
Paul C. Colonna, M.D., New York, N. Y.
James A. Dickson, M.D., Cleveland, Ohio.
G. E. Haggart, M.D., Boston, Massachusetts.
Clarence H. Heyman, M.D., Cleveland, Ohio.
J. H. Kite, M.D., Decatur, Georgia.
J. L. McDonald, M.D., Toronto, Canada.

Current Literature

The Treatment of Rheumatism in General Practice. By W. S. C. Copeman, M.A., M.B., B.Ch. (Cantab.), M.R.C.P. (London). With a Foreword by Sir William Hale-White, K.B.E., F.R.C.P., Hon. LL.D. Ed. 2. Baltimore, William Wood & Company, 1935. $3.25.

It is fortunate that an American printing of this sound and helpful volume of some 200 pages has appeared. The author is a medical practitioner whose viewpoint commands a wide horizon, whose experience is large, and whose appreciation of the needs of the general practitioner is acute. A review of the book fulfils Dr. Copeman's hope "that the reader will be satisfied that rheumatism should no longer be considered as an 'act of God' but may now be treated with a good prospect of success".

The arrangement of the material is excellent and somewhat unusual. The clinical aspects of the various "rheumatic" manifestations are considered first, with an outline of the general lines of treatment appropriate to each. The details of treatment, medical, surgical, and physical, are later elaborated and a chapter on prognosis is added. The style is lucid and often graphic. The writer escapes undue dogmatism, but no doubt is left as to the author's opinion. There is no hiding behind meaningless pseudodiagnostic names.

The proposed clinical classification of the rheumatic diseases is simple and practical and in agreement with the concept of the American Committee for the Control of Rheumatism. The exact etiology of many manifestations of rheumatism remains obscure or, at least, is not known to be specific. It would have been unwise, therefore, to attempt a purely etiological classification.

One of the most helpful and suggestive chapters is entitled, "Doctor and Patient". Proper emphasis is given to the supreme importance of winning the confidence of the patient, not by holding out false hope, but by making the effort seem worth while, and by overcoming the all too common "defeatism" which the past experiences of the patient have so often engendered. The psychological element is perhaps as important as any.

In Part III, the reader will find the details of medicinal, dietary, vaccine, orthopaedic, and physical therapy which the wide experience of the author has led him to adopt. The fact that other workers in this field may have reached somewhat different conclusions based on a different experience does not detract from the value of Dr. Copeman's book. If the general practitioner will approach these neglected diseases along the lines herein clearly set forth, the hopeless attitude toward them which now obtains will disappear, to the great satisfaction of the practitioner and to the great good of his patients.

Fractures du calcanéum. Le problème thérapeutique qu'elles posent. Hubert Mutricy. Paris, Librairie Louis Arnette, 1935.

This book considers the subject of fractures of the os calcis from a very general point of view, as well as from the author's own experience, which is given in the parts devoted to diagnosis and treatment. In this way, it presents an excellent review of the opinions of the principal writers on the subject and an analysis of the present methods of dealing with this difficult group of fractures.

The author emphasizes the necessity of having x-rays taken in two planes—evidently a practice which is too often neglected—for these cases may not always be accurately classified and treated by means of the information obtained from the usual lateral view of the fracture. An accurate classification is of practical value in determining the exact type of fracture and displacement and, from this, the mode of treatment.

The author compares the different methods of classification which have been described since Malgaigne's, but it is difficult to place all of the many varieties of these

fractures under any one of these classifications. That of Destot allows a grouping particularly with reference to the thalamus and to the crushing or displacement of this portion of the bone, and the author considers this one of the most essential factors, both in classification of the type of injury and in determining the most desirable method of treatment. Many types of fractures are analyzed with reference to the injury to the thalamus, as well as with reference to the complications associated with them, and the author regards this factor as probably the crucial one in influencing the choice of the mode of treatment to be used.

The large number of methods which have been advocated and practised are discussed, and the difficulties encountered in each are pointed out. The treatment is considered mainly under the headings of those cases which involve a fracture or displacement of the thalamus and those without a fracture of the thalamus; it is also divided into those cases in which an attempt at reposition is not advised on account of the severity and those in which there should be an attempt at replacement of the fragments.

The methods in vogue are described—those mentioned in the literature and those in use in the hospital in which the author is working—and a large number of cases are cited. The text is well illustrated and the work is a distinct aid to those who desire information on the care of this group of rather disabling injuries.

PRAKTISCHE ANATOMIE. Band I, Teil 3. By Dr. T. von Lanz and Dr. W. Wachsmuth. Berlin, Julius Springer, 1935. 29 marks.

Seldom does one find a work which so completely and accurately covers the subject as does this book. The underlying principle, which is evident throughout, is the giving of material which is of practical aid to the surgeon and to the medical practitioner. This volume is confined to the consideration of the upper extremity.

The arrangement for topographical study is excellent. By remarkably clear and accurate photographs, the relation of the contour of the arm to each of the underlying structures is shown, accompanied by a detailed description of these structures. The relation of each of the underlying structures to the others, as well as to the underlying skeleton, is also clearly described, and profusely illustrated with beautifully colored plates.

The first part of the volume is devoted to a very full description of the different structures and their development. The topography of each region is then considered.

The remainder of the book is devoted to a consideration of the different regions of the arm,—the shoulder, the upper and lower portions, the elbow, the hand, and the fingers.

Of especial practical value will be found the topographical anatomy of the shoulder region. The relations of the deeper structures to each other, to the contour, and to the bones and to the joints in different positions of the arm are shown. The change in relation of these structures in these different positions of the arm is usually not sufficiently emphasized. Therefore, this portion is of great value to the surgeon who is obliged to explore these deep and delicate regions and to use the different positions of the arm, according to the object of his surgery.

The lines of incision for reaching the different structures are given and special incisions are described for use in such operations as those of tying muscles and reaching nerves.

In the consideration of the nerve distribution, the nerve trunks of the plexus are shown in colors, and the same color scheme is then extended to the distribution of the branches of these trunks in different parts of the arm, including the supply of the muscles and the supply of the sensation of the skin. In the plates illustrating spaces, such as the axilla and different areas for operation, the various structures—nerves, arteries, veins, etc.—are shown in different colors, which bring out their relative positions most clearly. There is also a very excellent index which enables the reader to turn at once to the portion which he most desires to study.

The work is a model of thoroughness and accuracy. The text is brief, but clear, and is evidently the result of long study, and the illustrations are chosen to demonstrate the important anatomical relations with which the surgeon has to deal.

Backache. By James Mennell, M.A., M.D., B.C. (Cantab.). Ed. 2. Philadelphia, P. Blakiston's Son & Co., Inc., 1935. $3.50.

Backache is probably as old as mankind. Much has been written about it. Yet, when a book appears, the author of which is as thorough in the details of examination and diagnosis and as understanding in basing treatment on diagnosis and especially on differential diagnosis, as is the writer of this treatise, it may well be received as a real contribution to a difficult subject. Backache, like charity, covers a multitude of sins, both in diagnosis and treatment. This author realizes that correct diagnosis is essential.

The importance of a searching history taking is emphasized. In the chapter on examination, familiar procedure is followed, but the wisdom of definite sequence is urged. The author begins with the patient in the sitting position; then in the standing position, in which pertinent use is made of blocks placed alternately under one and the other foot; and, finally, in the lying positions,—the supine, the alternate side lyings, and the prone lying. In each of these positions, the author observes abnormalities without movement, makes careful digital examination for tender spots, and then notes the effect of many movements on the body mechanism. This chapter on examination presents a thorough and comprehensive procedure and is probably the most valuable contribution of the author. With the many tests used, one wonders that the author has not included the valuable examining position of half-prone lying at the end of the table, the trunk supported on the table with the feet resting easily on the floor. This position affords excellent exposure of the low back,—the lumbar spine, the lumbosacral joint, the sacro-iliac joints, the coccyx, the buttocks, and the upper thigh portions of the sciatic nerves.

The chapters on diagnosis and differential diagnosis constitute a summing up of the information obtained by the examination. It is logically presented, but is perhaps too detailed. Roentgenographic examination is used, but the author makes his diagnosis without much dependence upon it. Yet he recognizes its value in discovering spondylolisthesis, fractures, sacralization of the transverse process of the fifth lumbar vertebra, and injuries to the coccyx.

The long chapter on treatment is divided into treatment during the acute stage following trauma and treatment of the after effects of injuries. Under each of these subheadings, he individualizes the lesions. He lays much stress upon strains of the sacro-iliac joint. He uses manipulation, general rest, localized bracing and strapping, diet, and galvanism, and gives full and accurate descriptions of his methods of retraining posture. This chapter includes well known modalities and presents some valuable original procedures.

The book is well and helpfully illustrated. The author presents his thesis solely on the responsibility of his own experience. The reviewer believes that this experience fully warrants the appearance of the monograph.

The Doctor's Bill. By Hugh Cabot. With an Introduction by A. Lawrence Lowell. New York, Columbia University Press, 1935. $3.00.

With characteristic courage and with an independence, originality, and sagacity not surprising to those who know him, Dr. Hugh Cabot in his latest book attacks some of the problems of the present day practice of Medicine. His title, "The Doctor's Bill", connotes the economic and social aspects of these problems,—the questions of how the doctor's charge for his service is to be fairly made and met, and of how the bill of particulars is to be answered "in the case now coming before the bar of public opinion in the guise of the people versus the care of their health".

Dr. Cabot begins by sketching and contrasting the conditions of medical practice in the United States in the last decade of the nineteenth century and the fourth decade of the twentieth. He points out that the difference between these two pictures is due fundamentally to the enormous amount of new discoveries and inventions which have been made during this time, not only in medicine, but in all the sciences.

These phenomena have increased the cost, to the doctor and to his patients, of rendering medical service. The problem in every country, then, is how its resources can

best be utilized to provide adequate medical service to those in every economic bracket and to assure the physician sufficient and reasonable remuneration for that service.

To this end, Dr. Cabot appraises various policies and projects which have been tried in the effort to meet certain aspects of the fundamental problem in different states and countries. He surveys with an impartial eye medical needs in the United States under the headings of Community Health, Child Health, Preventive Medicine, Periodic Health Examination, The Private Practitioner, The Specialist; The Supply and Distribution of Physicians, Nurses, Dentists, and Hospitals; The Care of the Indigent and of the Low and Medium Income Groups.

As in all such cases, the solution of the problem must doubtless be a matter of progressive experimental approach and adaptation. In this approach, however, the medical profession should lead rather than be driven. Dr. Cabot further surveys some of the suggested methods of improvement in the United States,—Health Insurance, Voluntary Insurance against sickness both nationally and by regular Life and Accident Companies, Compulsory Health Insurance, and Guild Medicine. He feels that none of the methods generally advocated provides an ideal solution. One of three policies may be followed: either that of *laissez faire*, or that of adopting bodily a policy imported from some other country, or that of developing a policy and method adapted to our own necessities. In his final chapter, "Where Do We Go from Here?", Dr. Cabot considers a series of elements, some of which, it seems to him, should be incorporated in any such indigenous policy. These elements are the organization of the medical profession, the ability of medical organizations to discipline their own members, the free choice of physicians, free competition among physicians, limitation and distribution of the number of physicians, the payment of physicians for charity medical service, medical control of plans to distribute the cost of medical care, public health development, and more complete use of present medical personnel.

In the last analysis, it is the younger men upon whom the chief burden of the future will fall and to whom we must look with hope for solution, or approximate solution, of the problems now confronting us. It is to them that Dr. Cabot dedicates, and primarily addresses, his observations. In many respects the medical profession of today and of the future does not offer nearly as attractive a prospect as it did forty, or even twenty, years ago. If the development of cooperative living in the world is to become a reality, the individual can be assured only of modest competence, but this assurance should fairly outweigh the uncertainty of success or failure. What is needed in medicine, as in other professions and occupations, is the maximum of freedom and security for the individual within the limitations necessary for rendering his work most advantageous and serviceable to the community. The medical profession occupies a preeminent place in modern civilization and should justify its right to maintain that position by distinguished leadership, of the type which Dr. Cabot represents, in solving its own economic and social problems and in coordinating them with those of the particular communities which its members serve.

Verhandlungen der Deutschen Orthopädischen Gesellschaft, Neunundzwanzigster Kongress, October 8 to 10, 1934. Beilageheft der Zeitschrift für orthopädische Chirurgie, LXII, 1935. Stuttgart, Ferdinand Enke. 28.20 marks.

The *Verhandlungen* for last year are again well edited by Prof. Hohmann. They form a valuable record of the Twenty-Ninth Congress of the Deutsche Orthopädische Gesellschaft which was held in Dortmund under the presidency of Prof. von Brandes as reported in *The Journal* for January 1935.

The scientific section is divided by days into papers on: (1) the academic consideration of orthopaedic subjects; (2) the clinical aspects; and (3) the treatment with special reference to apparatus. The papers are of unusual variety and, with the discussions, are presented in full. Particularly noteworthy are those on neuromuscular mechanics and physiology, a symposium on the etiology and treatment of club-foot with particular reference to the newer conception of the primary skeletal deformity, the treatment of surgical

tuberculosis, and the late results following the shelf operation in congenital dislocation of the hip. Fracture of the neck of the femur, scoliosis, adolescent kyphosis, and coxa vara are discussed. The subject of proper shoes is reopened in a refutation of the tenets of Schanz.

The volume is an interesting record of recent trends in Germany as well as an excellent résumé of the orthopaedic contributions from this country for the past year.

The next meeting will be held in Cologne in 1936 under the presidency of Prof. Hackenbroch.

Orthopedics for the Teachers of Crippled Children. By Samuel W. Boorstein. New York, Aidem Publishing Company, 1935. $1.50.

This monograph is based on a series of lectures on orthopaedic surgery, given by the author to teachers of physically handicapped children in the New York public schools. It is not intended as a text-book of orthopaedic surgery, but as a brief manual for those who are to teach crippled children. It aims to present briefly and non-technically the essential facts of orthopaedic diseases and methods of their treatment. Simultaneously, it aims to inspire the teacher with an appreciation of the immense importance of sympathy, understanding, and the personal equation in dealing with the subjects of these diseases and endeavoring to help them master their defects and achieve success in life. In these aims, it succeeds admirably and should prove of great value to the group of teachers for whom it is intended, and to the pupils and patients with whom they deal.

Grundlagen der orthopädischen Mechanik. By H. v. Baeyer. Berlin, Julius Springer, 1935. 6.60 marks.

In fifty-six pages, the author covers the fundamentals of mechanics as applied to orthopaedic surgery. The material is presented in a very simple manner so that it can be followed with a minimum of effort. Diagrams representing forces and their effects demonstrate the essential principles graphically. Concise, explanatory notes facilitate the interpretation of the diagrams. This plan permits the inclusion of a large amount of valuable material in the short space allotted to the subject.

The booklet is a very valuable addition to the orthopaedic surgeon's library. While it does not in any way replace the course on mechanics obtained in a college, it supplies an excellent supplement in its application to the specific problems of the orthopaedic surgeon. It can be used with benefit in the teaching of courses on mechanics as applied to Orthopaedic Surgery, and should be of particular value to interns interested in bone and joint surgery.

The Journal wishes to acknowledge the receipt of the following publications sent to the Editorial Department:

Étude sur l'invagination intestinale. Basée sur 234 cas provenant de douze hôpitaux en Finlande. Rolf Gullichsen. Acta Chirurgica Scandinavica, LXXVI, Supplementum XXXV, 1935.

Postoperative Röntgenuntersuchungen. I. Diaphragmabewegungen und der postoperative Venenstrom. II. Postoperative Lungenembolien. J. Frimann-Dahl. Acta Chirurgica Scandinavica, LXXVI, Supplementum XXXVI, 1935.

On the Surgical Treatment of Pulmonary Tuberculosis. Johan Holst, Carl Semb, and J. Frimann-Dahl. Acta Chirurgica Scandinavica, LXXVI, Supplementum XXXVII, 1935.

Thoracoplasty with Extrafascial Apicolysis. Carl Semb. Acta Chirurgica Scandinavica, LXXVI, Supplementum XXXVII, 1935.

Bibliografía Médica Argentina, 1934. Universidad de Buenos Aires, 1935.

Bulletin of the National Tuberculosis Association (New York), XXI, Nos. 4, 5, 1935.

Medico-Surgical Suggestions (Madras, India), III, No. 12, 1934; IV, No. 1, 1935.

Scientific Programme of VIIth International Medical Post-Graduate Congress of the Tomarkin Foundation Inc. Brussels, 1935.

ÜBER DIE AUSHEILUNGSBEDINGUNGEN DER MEDIALEN SCHENKELHALSBRÜCHE NACH OSTEOSYNTHESE MIT EINEM NAGEL AUS ROSTFREIEM STAHL, ILLUSTRIERT DURCH EINE HISTOLOGISCHE UNTERSUCHUNG (The Requisites for Healing of Medial Fractures of the Femoral Neck after Osteosynthesis with a Nail of Rustless Steel, Illustrated by an Histological Study). Ivar Palmer. *Acta Chir. Scandinavica*, LXXV, 416, 1934.

The gross and microscopic examinations of the proximal end of the right femur of a seventy-year-old woman, three months after a fracture in which the fragments were nailed according to the Sven Johansson technique, stimulated the writer to study the literature and to conclude as follows:

In medial fractures of the neck of the femur, necrosis of the head did not prevent bony union. In the specimen examined, the distal fragment was partially absorbed and the neck shortened by twelve millimeters, with corresponding extrusion of the nail. This absorption was still going on three months after the injury, but bony union had commenced through metaplastic bone formation in the periosteal-synovial covering of the neck. Regeneration of the necrotic head took place after revascularization through capsule and periosteum.

Rustless steel had no deleterious effect on the spongy bone or on the processes of repair. There was living bone in close proximity to the nail. New bone was formed as actively and absorption was not more marked close to the nail.

Good reduction and maintenance of position are necessary, but are no guarantee of a satisfactory result.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

ZUR FRAGE DER DIAGNOSTIZIERUNG VON MENISKUSSCHÄDEN MITTELS ARTHROGRAPHIE (The Question of Diagnosing Semilunar-Cartilage Injuries with Arthrography). K. A. Lagergren. *Acta Chir. Scandinavica*, LXXV, 485, 1934.

By injecting knee joints with twenty cubic centimeters of 17.5 per cent. Perabrodil and taking oblique x-rays, the writer was able to demonstrate meniscal injuries in clinically uncertain cases. His descriptions of the type and extent of the injury were subsequently verified by arthrotomy. Histological and chemical studies of the joint fluid and the synovia showed no evidence of the damage which occurs when other contrast media are used. Instead a beneficial action was evident. Eight cases are cited as examples. X-rays after injection of both normal and abnormal knee joints are reproduced.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

ROENTGENOLOGIC STUDIES OF THE ORIGIN AND DEVELOPMENT OF JUVENILE KYPHOSIS, TOGETHER WITH SOME INVESTIGATIONS CONCERNING THE VERTEBRAL EPIPHYSES IN MAN AND IN ANIMALS. H. Scheuermann. *Acta Orthop. Scandinavica*, V, 11, 1934.

The writer offers a complete discussion of the disease bearing his name, which he first reported in 1920. At that time he considered the lesion to be an osteochondritis. He now thinks that the wedging may be due in part to the pressing of the cartilage layer of the vertebral body into the spongiosa. The change in shape begins at the time of appearance of the ringlike osseous center. This limbus may be totally absent, nearer than normal to the anterior corners of the vertebral body, posterior to its usual position, or grossly irregular in contour. Occasionally the changes appear before the limbus is visible in the roentgenogram.

The writer refutes Schmorl's theory that nuclear prolapse is the primary factor of wedging.

Eighteen cases are reported,—thirteen boys and five girls, ranging in age from nine to eighteen years. The deformity develops most frequently between the fourteenth and sixteenth years. The changes usually involve two to three vertebrae,—most frequently the ninth to eleventh thoracic. The prognosis is uncertain in the early stages. Mobile kyphotic spines may develop progressively severe, rigid kyphoses, while others may remain mobile and not progress.

An additional study is made of over 600 spines of animals.

The writer concludes that nuclear prolapse does not occur in mammals other than man.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Des exostoses cartilagineuses multiples. John Eriksson and Telemak Fredbärj. *Acta Orthop. Scandinavica*, VI, 21, 1935.

From a study of twenty-four cases, the writer concludes in part as follows:

Multiple exostoses occur as hereditary and non-hereditary diseases which appear alike clinically as well as roentgenographically. The inheritance is simply dominant, without any preponderance for either sex.

The writer agrees with Murk Jansen that the disease is the result of a dissociation of the normal mechanism of bone formation. Most of the exostoses develop through a defect of resorption, but a few are the result of independent proliferation,—that is, true osteomata.

Curvature of the bones may be due to partial inhibition of cell division, direct pressure of an exostosis upon adjacent bone, or altered static conditions. Inhibition of cell division over the portion of the surface of the epiphyseal cartilage may be primary or due to secondary pressure of an exostosis.

Retrogression and modification of the exostoses are frequent phenomena, due apparently to the mechanical influences of the surrounding muscles and tendons. Complete disappearance of an exostosis is demonstrated in two cases.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Chondrosarcoma. Béla Halpert and Jachin B. Davis. *Am. J. Cancer*, XXIII, 784, Apr. 1935.

The authors report two cases of this rather rare tumor, with detailed clinical histories and photomicrographs and drawings of the gross specimens. In one case the growth was primary in the tibia, and at the time of amputation the disease involved the patella, femur, and skin. In the other case, the growth was primary in a rib and involved the spinal epidural spaces, causing paralysis distal to the area involved. This patient also proved to have metastases to the lung. In each instance, the growth presented the structure of embryonal cartilage. Both patients gave a history of trauma prior to onset of the disease.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

Congenital Defects of the Lumbosacral Joints with Associated Nerve Symptoms. A Study of Twelve Different Types with Operative Repair. Lewis Clark Wagner. *Am. J. Surg.*, XXVII, 311, Feb. 1935.

Twelve cases are reported in detail in which the patients had various types of pain in the legs and back. The importance of the part played in these cases by congenital lumbosacral anomalies is well brought out. These anomalies are receiving more careful attention and are potential factors in the subsequent causes of low back pain. The symptoms usually occur in the third decade of life. The distribution of subjective pain may include the third lumbar segment to the third sacral segment, but it most frequently centers in the fifth lumbar and first and second sacral segments. In the author's series no definite paralysis occurred. Excision of long or impinging transverse processes is not satisfactory and may be associated with other changes and defects. Tumor of the spinal cord or radiculitis should be excluded. These cases explain causes of referred bizarre pain other than pressure or narrowing at the vertebral foraminae. The author's operative technique is well described and offers an excellent method of satisfactory and complete fusion of the lumbosacral area, including the articular facets. It seems superior to the use in this area, of the simple Albee graft which, unless carefully done, is usually difficult to fuse thoroughly.—*Custis Lee Hall, Washington, D. C.*

Demineralization of the Skeleton. A Report of Five Cases with Different Proved Etiology. S. K. Livingston. *Am. J. Surg.*, XXVII, 464, Mar. 1935.

Five cases are reported in detail, with diagnoses. An excellent table gives the differ-

ential diagnosis of conditions characterized by demineralization of the bones, including osteitis fibrosa cystica, osteitis deformans, multiple myeloma, metastatic malignancy, and osteitis fibrosa localisata. Recent work would tend to establish the various forms of osteitis fibrosa cystica and hyperparathyroidism and resultant changes in the skeletal structure as cause and effect, and x-ray treatment over the parathyroid will show marked improvement in the clinical and x-ray picture.—*Custis Lee Hall, Washington, D. C.*

OSTEITIS FIBROSA: AN EXPERIMENTAL STUDY. Hermon Taylor. *British J. Surg.*, XXII, 561, Jan. 1935.

This is an exceedingly thorough and interesting study of the biochemistry of osteitis fibrosa. The experiments were divided into two groups, those in which phosphatase was used and those in which parathormone was injected. The conclusions are as follows:

1. The high-plasma phosphatase in decalcifying disease is indicative of the extent of the bony reaction.
2. A suggestion is put forward with regard to the mechanism of the physiological process of ossification.
3. A distinction has been suggested between metabolic decalcification and the molding of the bones by osteoclasts.
4. Differences in phosphate metabolism between rabbits and human beings have been indicated.
5. These differences account for the compensation established in rabbits to the effect of parathormone.
6. Areas of bone showing the classical histological features of osteitis fibrosa have been produced in rabbits by parathormone.
7. These features have been shown to be the result of the healing of marrow hemorrhages and are not necessarily specific to the action of parathormone.
8. The giant cells have been shown to arise *in situ* by fusion of proliferating connective-tissue cells.
9. The giant cells so formed are indistinguishable from osteoclasts.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

FRACTURAS DE MONTEGGIA. Alberto Inclán. *Cir. Ortop. y Traumatol.*, II, 203, 1934.

In an article on the subject of Monteggia's fractures (fractures of the upper third of the ulna with dislocation of the head of the radius), Prof. Inclán gives the results of his experience with this injury and discusses the etiology, pathology, and treatment.

He believes that such a fracture should always be regarded as serious, that it demands early treatment, and that the prognosis is increasingly unfavorable as the interval between the injury and the treatment lengthens. He states that, without the integrity of the ulna, it is difficult to maintain the head of the radius in position,—there is a marked tendency to backward angulation of the ulna, delayed union is frequent, and radio-ulnar synostosis is not unusual. Therefore, correction must be maintained until there is complete union of the ulna.

The type of reduction selected, either open or closed, depends upon the individual case. The best position for immobilization is flexion at 90 degrees. The surgical repair of the old Monteggia's fracture is extremely difficult.

The histories of four recent cases and five old cases, treated on the author's Orthopaedic Service, are given. These cases illustrate very clearly the necessity of adapting the treatment to each individual case.

TRANSPLANTACIONES DE TENDONES EN LAS EXTREMIDADES SUPERIORES EN LA POLIOMIELITIS (Tendon Transplantation in the Upper Extremity in Poliomyelitis). Frank R. Ober. *Cir. Ortop. y Traumatol.*, III, 7, 1935.

The author presents a most interesting study of the different techniques employed in the rare surgical interventions performed on the upper extremities in order to correct the conditions following poliomyelitis. He mentions the principle operations per-

formed on the hand, wrist, elbow, and shoulder and presents a series of cases treated at the Children's Hospital, Boston, Massachusetts.

The study of the procedures used, especially those with reference to the shoulder, is most interesting and the excellent results obtained by the author in most cases prove their value.

The author arrives at the following conclusions:

1. Any transplant done to improve the function of the hand is worth doing if it increases the grasping power of the hand and if it restores, even slightly, the opposing power of the thumb.

2. Tendon transplantation at the wrist may be done to relieve deformity and to secure dorsiflexion of the wrist.

3. Muscle transplantation may be done at the elbow to restore partial flexion.

4. Whenever possible, muscle transplantation should be done at the shoulder, instead of arthrodesis, to restore abduction and to prevent subluxation of the joint.

All of the general rules for tendon transplanting elsewhere must be observed in the upper extremity if one wishes one's work to be attended with success.—*Alberto Inclán, M.D., Havana, Cuba.*

DIE KASCHIN-BECKSCHE KRANKHEIT IM RÖNTGENBILDE (Roentgenographic Aspects of Kashin-Beck Disease). W. Graziansky. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, L, 368, 1934.

The author has made a roentgenographic investigation of nine cases of Kaschin-Beck disease in which the ages of the patients ranged from nine to seventeen years. These patients were sent by the Soviet Government from Eastern Siberia to the Turner Institute at Leningrad.

Endemic in the vast Transbalkan area, the disease presents interesting pathological skeletal changes which stamp it as a distinct disease of youth and adolescence. This group of cases manifested the complete changes and ravages which, according to Beck and Lapacev, appear early in childhood, flare up during adolescence, and glimmer with advancing age. Heredity, whether in man or animal, shares marked responsibility for Kaschin-Beck disease. Toxic factors, coming from decomposed products of animal and plant life which pollute the Transbalkan streams, are also to be considered as causing the disease. Theories also are advanced which ascribe the cause of the disease to the lime content or radium activity of lead combinations in water. Social environment unquestionably contributes to the condition. Beck and Sergijewski find its incidence doubled in the Transbalkan area.

This disease presents three stages, all of which occur during the developmental period of life. Checking of growth and development of the smaller hollow bones is seen, and osteoporosis, although present throughout the course of the disease, is most pronounced in the third stage. Gross joint changes occur in the following order: ankle, knee, elbow, and wrist. The hip and shoulder joints show less disturbance. The epiphyseal and joint-cartilage manifestations are only the skeletal evidence of a general involvement affecting the viscera and neuromuscular systems. Grossly, a patient with Kaschin-Beck disease presents a short upper arm, as compared with the forearm and leg, and an increased shortening of the lumbar region, due to pulling downward and forward.

Disturbances of the ductless glands, producing skeletal changes, may simulate Kaschin-Beck disease. X-rays of the hand in a case of chondrodystrophia might be interpreted as Kaschin-Beck disease; in fact, contrary to the Russian authorities, Bracher believes the two conditions identical. The mature patient with Kaschin-Beck disease is more or less of an invalid, with symptoms indicating some derangement in the greater articulations. The hips and shoulders are commonly spared in chondrodystrophia. Skeletal sections in Kaschin-Beck disease, especially as the trunk is approached, show little change from normal beyond the porosity of the short hollow bones, which is not present in chondrodystrophia. Rocklin and Simonson consider chondrodystrophia analogous to the second stage of Kaschin-Beck disease.

Further roentgenographic studies of the hands and feet in the nine cases presented were made after a period of one and one-half years. These roentgenograms showed the disease as definitely checked by only a change in environment and habitat. The progress of the disease was arrested and the deformities at the epiphyses and in the joints remained *in statu quo*. Strengthening occurred, especially of the long bones at the epiphyseometaphyseal ends. The weak osseous centers became thicker and more sclerotic. The cortex was heavier. No new synostoses formed and skeletal development progressed uninterruptedly, especially in the younger patients. The author has presented a series of excellent and valuable reproductions of his x-ray investigations. —*Alfred J. Buka, M.D., Pittsburgh, Pennsylvania.*

What Should a Patient with Arthritis Eat? Walter Bauer. *J. Am. Med. Assn.*, CIV, 1, Jan. 5, 1935.

The question put forth in the title is an all important one to both physician and layman. To answer this question intelligently, an accurate knowledge and diagnosis of the process is necessary.

In those arthritic conditions of known etiology, the diet is that indicated for the treatment of the particular disease or in combating the etiological agent. The one exception in this group is gout. Here the diet is low in purines. It might be said that, with the exception of gout, there is no specific diet for arthritis of known etiology. Arthritic conditions of unknown etiology include degenerative arthritis (hypertrophic), proliferative arthritis (rheumatoid arthritis), and rheumatic fever.

Degenerative or hypertrophic arthritis is considered by most authorities to be due to trauma. At autopsy, the knee joints show characteristic changes in the joint surfaces, which may be attributed to the "wear and tear" of age rather than to some inflammatory process, metabolic upset, or endocrine imbalance. In these patients, a diet which attempts to reduce the weight, but at the same time meets the caloric requirements of the body, is helpful in reducing trauma.

Proliferative or rheumatoid arthritis is characterized by proliferation of the synovia and connective tissues of the subchondral spaces and round-cell infiltration. The process is not to be confused with the degenerative or hypertrophic type. It is important to remember the characteristic remissions and relapses which so frequently occur. A lapse of five years, preferably ten, should be allowed before a definite cure is pronounced. Numerous diets have been prescribed for rheumatoid arthritis; these include: (1) omission of acid fruits and vegetables; (2) the taking of one type of food at a time (fat, protein or carbohydrate); (3) alteration of the acid-base balance of the diet; (4) omission of food to which patient is hypersensitive; (5) low-protein intake; (6) low-carbohydrate intake. In those cases where there is some food sensitivity, that food should certainly be removed from the diet, but these instances are rare. The other suggestions cited which have no physiological basis are contra-indicated. The proper diet is well balanced, and sufficient in caloric and vitamin content to care for the body needs of the patient.—*Ike Kendrick, M.D., Dallas, Texas.*

Disabilities of Hand Resulting from Loss of Joint Function. Sumner L. Koch. *J. Am. Med. Assn.*, CIV, 30, Jan. 5, 1935.

Loss of motion in the joints of the hands presents a serious problem. Restoration of function by operative measures is uncertain and often unsuccessful. The difficulties encountered cause greater emphasis to be placed on the preventive treatment.

After joint fixation has occurred, some form of active treatment must be given in order to restore movement. Four methods are available: splinting and physical therapy, manipulation, extra-articular operation, and intra-articular operation.

In those cases in which fixation is not absolute, considerable improvement can be obtained by splinting and physical therapy.

Manipulation has been found to be useless except in cases of injury or infection in

which intra-articular or periarticular bands do not completely block movements, but limit them and cause pain.

Good results have been obtained by the author from an extra-articular operation in which the dorsal aponeurosis is divided and the collateral ligaments released.

Of the intra-articular operations, the author reports arthroplasties at the wrist, metacarpocarpal, metacarpophalangeal, and interphalangeal joints. The results have not been good in all cases. Of eleven arthroplasties of the wrist, the results are reported as excellent in four. The author concludes that, although the results in a number of cases are not perfect, definite improvement has been obtained in a number of instances and that, with greater operative care and more persistent efforts to secure active movements following operation, still better results can be obtained.—*W. B. Carrell, M.D., Dallas, Texas.*

CONGENITAL DISLOCATION OF THE HIP. STATISTICAL ANALAYISIS. Arthur Steindler, Jacob Kulowski, and Ernest Freund. *J. Am. Med. Assn.*, CIV, 302, Jan. 26, 1935.

This is a statistical report of 501 dislocated hips seen in 387 cases. Particular reference is made to the end results obtained by various procedures.

Closed reduction was considered the method of choice in unilateral cases up to five years of age and in bilateral cases up to six years of age.

Open operations were used as supplementary measures or when the closed methods failed. The closed method in patients up to five years of age failed in 7.5 per cent. of the cases. Results and indications for palliative operative procedures—such as shelf operations and osteotomies—are also given.

The authors stress particularly the fact that end results can only be evaluated after adolescence has been attained, as so frequently alterations are observed in the growth and shape of the acetabulum and head. Results usually become definitely worse in proportion to the duration of the observation period.

This is a timely and excellent presentation of one of the orthopædic surgeon's greatest problems and is worthy of most careful consideration.—*P. M. Girard, M.D., Dallas, Texas.*

COXA MAGNA. A CONDITION OF THE HIP RELATED TO COXA PLANA. Albert B. Ferguson and M. Beckett Howorth. *J. Am. Med. Assn.*, CIV, 808, Mar. 9, 1935.

The authors explain the relation between coxa plana and coxa magna as one of difference in degree of interference with the circulation of the femoral head. They believe that in coxa magna the interference with the circulation comes from partial sclerosis and thickening of the soft tissues about the femoral neck as a result of infection, usually arthritis.

The treatment outlined is rest in bed, without any form of fixation, and removal of the foci of infection.—*P. M. Girard, M.D., Dallas, Texas.*

UNILATERAL SUBLUXATIONS OF THE CERVICAL VERTEBRAE WITHOUT ASSOCIATED FRACTURE. Barbara B. Stimson and Paul C. Swenson. *J. Am. Med. Assn.*, CIV, 1578, May 4, 1935.

The authors report sixty-six cases seen on the Fracture Service of the Presbyterian Hospital since January 1, 1929. The condition is not new, but is more often recognized by means of the stereoscopic roentgenograms described. The condition occurred slightly more often in males than in females, and most of the patients were seen shortly after receipt of the trauma. The etiology is most often an injury when the muscles are off guard,—a sudden twist of the neck, a turn of the head, or some mild trauma transmitted in just the proper direction.

The treatment consisted of head traction in seventeen cases and hyperextension of the neck, after the method described by Stookey, in seventeen other cases. In cases where the subluxation was easily reduced, the patients wore Schong collars for from ten to fourteen days. In the cases where reduction was less easily accomplished, plaster col-

lars were worn for four weeks. In five of the sixty-six cases, recurrence took place, due to the patients' lack of cooperation in wearing the collars for the prescribed length of time.—*W. B. Carrell, M.D., Dallas, Texas.*

Back Strain and Sciatica. Frank R. Ober. *J. Am. Med. Assn.*, CIV, 1580, May 4, 1935.

The purpose of the paper is to present a new theory relating to the cause of lame backs. In the absence of x-ray evidence of pathology in the sacro-iliac or lumbosacral regions, a positive diagnosis of sacro-iliac or lumbosacral strain is a difficult one. In the examination of many patients of this type, the author has discovered that the iliotibial band is an important factor in the occurrence of lame backs with or without associated sciatica.

The origin and insertion of the iliotibial band is described, as well as the manner in which the tendon of the gluteus maximus muscle enters its posterior part.

The pathology and symptoms are discussed and the characteristic findings at examination are described.

Relief of the contracture is the essential factor in the treatment. In patients without sciatica, stretching exercises may relieve the pain. In those patients with severe sciatica, operation is indicated. The operation consists in transverse division of the fascia lata from below the anterior superior spine to the anterior border of the gluteus maximus muscle.

In several cases, the results of treatment were dramatic. In some instances, the sciatica lasted for from six to eight weeks. Thirteen patients have been operated upon with relief in all but one case.

Five cases are reported, in all of which the patients obtained relief from their symptoms.—*Ike Kendrick, M.D., Dallas, Texas.*

Treatment of Progressive Pseudohypertrophic Muscular Dystrophy. J. H. Kite. *J. Med. Assn. Georgia*, XXIV, 59, Feb. 1935.

In this article, the points of differential diagnosis between the "dystrophies" and the "atrophies" are outlined, because these are two separate disease entities and require different forms of treatment.

Forty-four cases of progressive muscular dystrophy are reviewed. It is interesting to note that all of these patients were males. Three-fourths of these patients began to have symptoms before the age of five. It has been found that the earlier the onset the poorer is the prognosis. Any illness which confines the patient to his bed or restricts his activities causes an increase in the severity of the symptoms; hence, casts and operative treatment are contra-indicated.

Six patients with progressive muscular dystrophy were treated with epinephrine and pilocarpine, and have been followed from one to two years. They showed a temporary improvement while under treatment and developed a certain amount of euphoria. It could not be said with any degree of certainty that a single case was arrested for a longer period than is sometimes observed in untreated cases. Certainly none of the patients were cured.

During the past two years, patients with progressive muscular dystrophy have been helped by feeding them glycine and other amino-acids. The literature has been reviewed and the results, obtained by various workers, warrant the further use of amino-acids.

Since there is so little that can be done for these unfortunate children, attention is called to these two new methods of treatment in the hope that they will be used by the family physician.

A bibliography is appended.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

Arthroses déformantes du genou et pied plat valgus (*Deforming Arthrosis of the Knee and Pronated Flat-Foot*). Boppe. *Presse Méd.*, XLII, 2077, 1934.

The author reports two cases of the type of deforming arthrosis of the knee joint,

which is frequently associated with flat-foot. The condition was described by Böhler as "the painful knee of fat women". It is characterized by pain mainly along the inner aspect of the knee joint, particularly after exertion. Crepitus may be noted on motion of the knee joint, which is held in a slight degree of fixed flexion contracture, complete extension being impossible. There is definite internal torsion of the tibia, with pronation of the hind part of the foot, and abduction and equinus of the forefoot.

The author has achieved satisfactory results by realigning the foot. In advanced cases, osteotomy of the tibia to correct the rotational deformity may be necessary. The author calls attention to the absolute necessity of correction of lateral deformities of the knee joint and flat-foot during infancy, to prevent later development of arthrosis.—*Henry Milch, M.D., New York, N. Y.*

A PROPOS DU TRAITEMENT CHIRUGICAL DES FRACTURES RÉCENTES D'UN PLATEAU TIBIAL (Recent Subarticular Fractures of a Single Tibial Plateau). X.-J. Contiades et A.-M. Politis. *Presse Méd.*, XLIII, 44, Jan. 9, 1935.

The authors report two cases of the type of fracture originally described by Dehelly,—*a comminuted depression fracture, mainly of the external condyle of the tibia. It is* produced by hyperabduction of the leg with telescoping of the superior articular surface of the tibia between the condyle of the femur and the head of the fibula. The symptoms of this type of fracture are traumatic hemarthrosis, localized tenderness over the external condyle of the tibia, marked limitation of motion, and occasionally increased lateral motion. The fracture is best seen in anteroposterior views and should be carefully differentiated from the typical fractures of a whole or part of the tibial condyle. This fracture is frequently associated with injury to the lateral meniscus.

The authors advise wide arthrotomy and gentle upward levering of the depressed portion of the articular surface. The space left after the elevation of the articular surface is obliterated by several small autogenous bone grafts, which serve at the same time to prevent depression of the fragments. Following operation, the leg is immobilized in plaster for a period of about two weeks. After preliminary novocain infiltration of the periarticular structures, gentle active and passive motion is then begun.—*Henry Milch, M.D., New York, N. Y.*

INFLUENCE DE QUELQUES MÉTAUX SUR LA FIXATION DES COMPOSÉS MINÉRAUX DANS LES CULTURES D'OSTÉOBLASTES. CONTRIBUTION À L'ÉTUDE BIOLOGIQUE DE L'OSTÉOSYNTHÈSE. G. Menegaux and D. Odiette. *Presse Méd.*, XLIII, 152, Jan. 26, 1935.

Continuing their previously reported work on the influence of various metals on cultures of osteoblasts, the authors show that only three different varieties of steel, called V2A extra, Nicral D, and Platino-Stainless D, are available for use in subcutaneous fixation of bone defects. They had previously shown that practically all metals except these three and duralumin exercised a deterrent effect on the growth of bone cells. Their present studies confirm these previous observations by showing that duralumin must be added to the group of metals which exert a harmful influence on bone growth by their cytotoxic action, as well as by interfering with deposition of calcium salts.—*Henry Milch, M.D., New York, N. Y.*

L'ÉPIPHYSITE VERTÉBRALE. Prof. Laquerrière. *Presse Méd.*, XLIII, 191, Feb. 2, 1935.

The author gives a brief review of the condition and calls attention particularly to the differential diagnosis between the kyphoses due to vertebral epiphysitis, Pott's disease, and muscular relaxation. The differentiation is to be made mainly by roentgenograms taken in the lateral and anteroposterior positions. Of these, the lateral view is the more important. In the kyphosis due to relaxation, there is usually no tenderness nor pain. The kyphosis involves the whole spine and in the lateral x-ray the vertebral spaces are seen to be broader posteriorly and narrowed anteriorly. In Pott's disease there is more or less constant pain, definitely localized and accentuated by percussion or by move-

ment of any sort. In the lateral x-ray, the condition is usually seen to be localized and shows definite involvement of the intervertebral spaces and subsequently of the adjacent bone. In vertebral epiphysitis, while sudden motion may be painful, slow, gentle movement usually causes no pain, no restriction of motion, and no radiation of pain. In the lateral x-ray, the condition is usually found to be multiple and the vertebral interspace is completely intact, the kyphos resulting primarily from wedging of the vertebra.—*Henry Milch, M.D., New York, N. Y.*

LA DÉSARTICULATION DE LA HANCHE SOUS L'HÉMOSTASE PROVISOIRE DE L'ARTÈRE ILIAQUE PRIMITIVE OU DE L'HYPOGASTRIQUE CORRESPONDANTE. C. I. Ghitzesco. *Presse Méd.*, XLIII, 243, Feb. 13, 1935.

The control of hemorrhage is one of the most serious problems of this formidable operation. Numerous methods for control of hemorrhage have been devised. External digital compression of the femoral artery is apparently insufficient because of the flow of blood which occurs through the branches of the internal hypogastric artery. The use of the Esmarch bandage is unsatisfactory because it interferes with the surgical procedure. The abdominal tourniquet, while efficacious, may be fraught with fatal consequences. Of the methods of ligature, that applied to the femoral artery is only partly successful because of the blood flow through the branches of the internal iliac artery. Ligature of the common iliac artery is dangerous in that it may lead to necrosis of the flaps. Ligation of vessels exposed during the operative procedure is probably the most satisfactory method, but it prolongs the operation and necessitates the exact anatomical knowledge of the location of the different vessels. The author suggests the following method of temporary occlusion of the common iliac artery.

The common iliac artery is exposed through a pararectal incision and a ligature is passed beneath the common iliac vessel. The ligature is then drawn upward through the abdominal wall, angulating the common iliac artery and obstructing the flow of blood. The abdominal wound is closed in layers with the ligature protruding through the incision and, at the termination of the operation, the ligature around the iliac artery is cut and the artery permitted to fall back to its normal position. The author states that by this method he has operated upon three patients with satisfactory results.—*Henry Milch, M.D., New York, N. Y.*

OSTEITIS TUBERCULOSA MULTIPLEX CYSTICA. WITH REPORT OF TWO CASES. Jacob H. Vastine and Emily P. Bacon. *Radiology*, XXIV, 22, Jan. 1935.

There are two types of tuberculosis of the bone. The first and most common is the form occurring in the region of the metaphysis, where there is usually only one bone and joint involved. The dissemination is hematogenous and the predilection of the metaphyseal region, according to the work of Lexer, is to be found in the peculiar vascular structure of the growing long bones in this region.

The second and rarer form of tuberculosis of the bones is that involving the diaphysis, and is usually multiple. The dissemination is probably hematogenous. Fibrosis frequently predominates, surrounding the caseations and resulting in a cyst which remains comparatively quiescent and unchanged over a rather long period.

Cystic tuberculosis of bones in children is due to a dissemination of the tubercle bacilli through the blood stream, probably from a broken-down, caseous lymph node in the chest. The condition is probably present, but unrecognized in many cases of infantile tuberculosis.

Jüngling says that the roentgenogram is characteristic and is the chief means of distinguishing tuberculids of the bone. There is rarefaction originating in the marrow, which may be single or multiple. The process may spread diffusely through the entire involved bone, or it may appear as a circumscribed rarefaction in certain sites of predilection, particularly in the heads of the phalanges where the condition is nearly always multiple.

In the diffuse type, the cortex and medulla cannot be differentiated. The entire

bone is characterized by a weblike structure of increased density. This type is the initial stage and represents the more acute and florid process. In the large diffuse type, there may be destruction of the entire phalanx or there may be destruction to the extent that spontaneous fractures occur.

The circumscribed type is characterized by a round, rather smoothly outlined, punched-out area of decreased density. The cortex is a paper-thin shell which may or may not be penetrated. There may be a faint ring of sclerosis about these cystic areas, or there may be simply a clear-cut margin, with no alteration in density of the surrounding bone. The cortex is shown to be either expanded or destroyed. This circumscribed type represents a healing stage.—*Edward N. Reed, M.D., Santa Monica, California.*

Quelques notes sur la scoliose et le dos rond. Leur cause et leur traitement (Observations on Scoliosis and Round Back. Their Cause and Treatment). Murk Jansen. *Rev. d'Orthop. et de Chir. de l'Appareil Moteur*, XXI, 38, 1934.

The author discusses the etiology as well as the prophylaxis and pathology of scoliosis. He considers it from the time of earliest infancy and states that children should not be allowed to sit before they are able to walk. He calls attention to the asymmetry of the diaphragm, as well as of the cavity and of the lungs, which results in the exertion of an unequal force on the spinal column. This causes a condition which definitely resembles the ordinary scoliosis found in later life and also in a tendency in the sitting position to a marked anteroposterior curve. This curve in turn is followed by the development of the four curves which are so often found later.

The four forms of scoliosis are described in detail. There is the more frequent dorsal or "habitual" curve, which has been so often attributed to the overuse of the right hand and sometimes is known under the name of "physiological scoliosis". Later, the two compensatory curves develop; these are usually referred to as compensation or balanced curves. During school days, the fourth form may be seen clinically; this is related to the asymmetry of the diaphragm and is known as total left scoliosis. It is well understood that in the weakened child the force of growth is diminished. The retardation of growth with the increase of the pressure should be considered as a manifestation of the increased sensibility to fatigue of the cells during growth. This retardation of growth appears clinically in genu valgum and in coxa plana incipiens.

Jansen considers that frequently the value of gymnastic exercises is overestimated. Gymnastic treatment is not able to bring about correction and overcorrection of the curve. The application of the tension by plasters also adds to the general weakness of the muscles of the patient. The principles of treatment which the author advocates are: (1) the treatment should be continued throughout night and day; (2) the corrective force should be applied to a single curve, usually on the more pronounced mediodorsal; (3) with very young children the curve should be reversed; (4) in older cases, the curve treated does not in any way reverse itself; only the two extremities are reversed. Apparatus for use both night and day is described, and there are numerous photographs showing the application of this treatment and the results which have been obtained.

Fractures of the Patella. Willis C. Campbell. *Southern Med. J.*, XXVIII, 401, May 1935.

The treatment advocated by the author is the placing of an anterior loop of rustless steel wire around the fractured patella. The skin incision is transverse, just below the fracture and concave upward. The lateral tear in the capsule is sutured with catgut and the skin closed. After ten days, when the wound has healed, active motion is begun. The wire seldom causes trouble, but can be removed under local anaesthesia if desired.

Ununited fractures of the patella are also discussed.

Unless there is some contra-indication, practically all cases are operated upon if there is any separation of the fragments.

A table is presented in which are given the anatomical end results obtained in 124 cases of fracture of the patella.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

Operative Treatment of Impacted Fractures of the Os Calcis. A. D. Oserow and A. M. Ssolondsj. *Soviet Surg.*, VI, 284, 1934.

The internal structure of the os calcis shows an area of normal rarefaction in the spongiosa below the sinus tarsi and under the anterior half of the superoposterior articular surface. The x-ray reveals it as an area of lighter density. In this area, compressed fractures usually occur. Three types are described according to the gravity of the fracture. A short history of the operative treatment is given. The authors consider the operative treatment as the most rational and in their cases have used a modified Lenormant-Willmouth operation. Five patients were thus treated, with one unsatisfactory result in a patient who was operated on three weeks after injury. The patients have returned to work within three and a half to four months.—*Emanuel Kaplan, M.D., New York, N. Y.*

Concerning the Technique of Treatment of the Calcaneus Deformity of the Foot. M. I. Kusslik. *Soviet Surg.*, VI, 483, 1934.

Two types of calcaneus deformity are recognized and a critical review of the treatment is given. Manipulation followed by fixation, operative procedures on the bony structures, or tendon transplantations are used. Transplantation of tendons of active muscles into tendons of paralyzed muscles should never be done. For those cases in which a transplantation of the peroneus longus is required, the author proposes the following procedure.

An incision is made along the outer border of the Achilles tendon from the junction of the upper and middle thirds of the leg to a finger-breadth above the plantar border of the heel, and carried parallel to this border and internally to the internal border of the heel. Another incision is made between the external malleolus and the base of the fifth metatarsal. The peroneus longus is cut at this point and the wound is closed. The peroneus longus tendon is pulled out through the first incision, and the Achilles tendon is shortened and sutured. The peroneus longus tendon is then pulled through a channel drilled in the os calcis and sutured to itself. The channel may be horizontal or, according to a coexisting varus or valgus deformity, made oblique toward the outer or inner side of the os calcis. The deformity must be overcorrected before suturing the tendon.—*Emanuel Kaplan, M.D., New York, N. Y.*

TABLE OF CONTENTS

(*Continued*)

List of Advertisers—July 1935

Transactions of the American Orthopaedic Association

Volume I of *The Journal* (then called the *American Journal of Orthopaedic Surgery*), published in 1903, took the place of Volume XVI of the Transactions of the American Orthopaedic Association. From time to time *The Journal* has requests for copies of the volumes issued prior to that date. Any reader having copies of these earlier volumes, which he is willing to dispose of, is requested to write to *The Journal*, indicating volumes available and selling price.

ADDRESS

THE EDITOR

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